Talking Books: Pioneering and Beyond

National Library Service for the Blind and Physically Handicapped

The Library of Congress

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National Library Service for the Blind and Physically Handicapped

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Librarians of Congress

The Library of Congress has provided library services for blind and, since 1966, physically handicapped readers, under the administration of the following Librarians of Congress:

John Russell Young	1897-1899
Herbert Putnam	1899-1939
Archibald MacLeish	1939-1944
Luther Harris Evans	1945-1953
Lawrence Quincy Mumford	1954-1974
Daniel J. Boorstin	1975-1987
James H. Billington	1987-

Administrators of the National Library Service Program

From 1897 to 1946, the Library of Congress provided direct library service to blind readers through Service for the Blind under:

Etta Josselyn Giffin	1897-1912
Gertrude T. Rider	1912-1925
Margaret D. McGuffey	1925-1927
Maude G. Nichols	1927-1946

In 1946, Service for the Blind, still headed by Maude Nichols, became part of the Library of Congress organizational unit that in 1931 had begun producing and distributing to regional libraries for circulation reading materials for blind readers. Initially called the Project, Books for the Blind, and now known as the National Library Service for the Blind and Physically Handicapped, this program has been administered by:

Herman H.B. Meyer	1931-1935
Martin A. Roberts	1935-1940
Robert A. Voorus	1940-1944
Joseph P. Blickensderfer	1945-1946
Xenophon P. Smith	1946-1948
George W. Schwegmann, Jr.	1948-1951
Donald G. Patterson	1951-1957
Robert S. Bray	1957-1972
Frank Kurt Cylke	1973-

Foreword

As with the printed book it has been technology that has made talking books possible and user friendly. And it is through universal acceptance of new technologies that the wonders of the talking book are available to blind and physically handicapped peoples of all nations. The emerging universal talking-book technology has world-wide acceptance. Nearly all countries are now using standard Philips cassettes—either two- or four-track format—and this has allowed the easy production, sale, and exchange of recorded books among all nations.

Technology has made possible the universal use and sharing of human knowledge. Let us hope that the goal of universal standardization for talking books will soon be realized.

Frank Kurt Cylke
Director
National Library Service
for the Blind and
Physically Handicapped

January 1988
Washington, DC

Preface

The story of how talking books developed is not simple and straightforward. Rather, it is a tale of starts, stops, and detours. It reveals a continuing dialog between those who knew what was technologically possible—the commercial audio producers—and those who knew what was needed—associations of and for blind and physically handicapped people. It focuses on the challenge to find or develop technology that would better meet very specialized needs. The story documents breakthroughs, such as self-contained cassettes and voice-indexing, as well as frustrations when carefully developed advanced designs were scuttled because of practical considerations. The story reveals, too, the effects on talking-book development of outside events—the World Wars, the Great Depression, and budget cuts. We learn, ultimately, that the talking-book program was destined to be a compromise between the search for the best possible product and the limitations of what was practical and economically feasible.

Researching and integrating the talking-book story was not easy. Some of the existing records were buried in files not readily accessible and were sometimes discovered only by accident. In turn, some key persons have disappeared from the scene. This study is the result of an attempt to synthesize the information available. It is a product of many phone calls, much interviewing and cross-checking, and insistent searching in old files.

Perhaps information exists that was not found by the author of this study. If so, publishing these findings may elicit further revelations. In any case, the reader has here both an inspiring story of the way in which people have pooled their ingenuity and challenged technology in order to provide a needed human service, and a tale of trial, error,

and eventual success against a changing political and economic background.

Many people assisted in bringing this study to publication. Dr. Edith L.R. Corliss, who worked on talking books under a National Bureau of Standards contract with the National Library Service for the Blind and Physically Handicapped (NLS), was an especially helpful source of information and direction. Ralph E. Garretson, head of NLS's Engineering Section, also provided first-hand information and verification of data. Ruth Nieland, NLS writer-editor, assisted in preparing the manuscript and monitored production.

Marilyn Lundell Majeska

Improvements in audio technology have made today's talking books easy to use and enjoy. (Model C-1 shown here.)

Introduction

Today the term *talking books* is recognized across the nation. It identifies a program that since October 1934 has been providing recorded materials free to persons physically unable to read the printed page. This study outlines the development of the talking-book program from its beginnings through 1987, focusing on the developments in audio technology that have led from thirty-pound reproducers playing brittle shellac records to the sleek, transistorized record players and cassette machines of the mid-1980s, with their capacity to provide hours of uninterrupted listening.

The Library of Congress began its service to blind and handicapped persons on March 3, 1931, when President Herbert Hoover signed into law the Pratt-Smoot Act. The law mandated that embossed books be provided to adult blind residents of the United States and that these books be circulated through a number of libraries designated as regional centers. Shortly after the bill was passed, Congress appropriated $100,000 for the Library of Congress to use in carrying out the provisions of the bill during fiscal year 1932.

The Pratt-Smoot Act was both a culmination and a beginning. Since the turn of the century, a number of libraries had been responding to requests from blind individuals for library service, and, in fact, a special reading room for blind people was established at the Library of Congress when its new building was opened in October 1897. A few years later, in 1904, the federal government instituted free mailing privileges to libraries that wished to mail brailled materials to blind individuals. Despite the mailing privileges, however, a 1928 study by the American Foundation for the Blind (AFB) revealed that fewer than ten thousand blind persons were using library facilities. In addition, libraries

Reading braille requires sensitive fingertips.

wishing to expand their facilities to reach more blind people discovered a problem—very few brailled books were available and library patrons soon exhausted the supply at any given library. With the passage of the Pratt-Smoot Act and the subsequent appropriation from Congress, a considerable sum of money was finally available for production of braille books.

In response to the passage of the Pratt-Smoot Act, the Library of Congress established the Project, Books for the Adult Blind, on July 1, 1931. Nineteen libraries, among them the Library of Congress, were named regional libraries. During the project's first year of operation, 157 books were selected for reproduction in braille. A survey done by AFB for the American Library Association (ALA) in 1928, however, revealed that fewer than 20 percent of the blind population could read

braille well enough to comprehend books in braille and only about 10 percent knew braille well enough to enjoy reading embossed materials.[1] The majority of people who lose their sight do so after age fifty, when learning braille may be difficult because of lessening fingertip sensitivity. Long before the ALA study was conducted, Robert Irwin, executive director of the AFB, had been considering a new medium for providing blind individuals with reading materials. He once told a friend, "I have always dreamed of books on phonograph records ever since my first hearing of a squeaky Edison cylinder."[2] Thomas Edison himself, in fact, had

Thomas Edison with his rotating-cylinder phonograph. (from Library of Congress collections)

suggested that the phonograph could be used to provide recorded books for blind readers.[3] When applying for a patent on his tinfoil phonograph in 1877, Edison listed "phonograph books, which will speak to blind people without effort on their part," as one of ten potential uses for his invention. Books for blind people were, in fact, listed second; music came in fourth.[4] It did not take long for other people to think along the same lines. At an ALA meeting in 1906, H. H. Ballard, a librarian from Massachusetts, said, "May I suggest the use of the phonograph for blind persons."[5] But before talking books could become a viable medium, phonograph and record technology needed considerable development.

Many years were to elapse before Ballard's suggestion was acted on. Thanks, however, to the technological developments in the 1920s and 1930s and the galvanizing force of AFB's Irwin, interest in providing talking books for blind readers grew steadily. In the summer of 1932, Senator Smoot and Congresswoman Pratt, authors of the 1931 bill that provided annual appropriations for the Project, Books for the Adult Blind, filed an amendment to include books in recorded form in the bill. The amendment met with only lukewarm endorsement from Librarian of Congress Herbert Putnam, who while agreeing that merely adding another form of books seemed in "principle consistent" with the original bill, questioned whether record technology was sufficiently perfected and noted that blind people were not supplied with the special phonograph that would be needed to play a talking book.[6] The AFB agreed to raise the money for 1,200 machines if Congress would appropriate money for talking-book records. The legislature agreed, and the amendment authorizing the government to provide books "in sound-reproduction records" was passed in 1933 (Public Law No. 439, March 4, 1933). Slightly more than a year later, in May 1934, talk-

ing books were granted the same free mailing privileges given to embossed books.

The talking-book program of the Library of Congress was inaugurated in October 1934. Even before its inauguration, AFB had been generating publicity for the program; on September 26, 1934, in fact, the John Wanamaker store in New York City turned over its auditorium and stage to AFB for a demonstration and discussion of talking books. The demonstration was part of a general campaign to inform the people of New York State about talking books.[7] By the following year, twenty-seven titles were ready for distribution to blind readers through the Library of Congress program; the materials were distributed via twenty-four distribution centers spread across the country. The Bible, historical documents (among them the Declaration of Independence and the Constitution), a number of Shakespeare's plays and poems, and a variety of fictional works were among the first talking books produced.

Readers share a 1930s talking book.

The Early Years: 1932-1945

Edison's tinfoil phonograph used rotating cylinders coated with tinfoil, wax, hard rubber, or a similar substance and a vertically moving stylus; each cylinder had to be recorded separately. It was not until the invention of the flat disc with its potential for mass production that Edison's predictions for the phonograph became real possibilities. But the medium had some serious drawbacks, especially as a means to record books. A major drawback was the length of time each side of a record played. The standard ten- and twelve-inch records, recorded at a speed of 78 revolutions per minute (rpm), played for only three and five minutes, respectively, per side. The records, which by the early 1930s were made of shellac, were also expensive, heavy (a twelve-inch record weighed more than half a pound), and easily broken.

But technological advances were being made, spurred on by the introduction of radio and that medium's need for less fragile records with longer playing times. The popularity of the talking motion picture also led to considerable money being poured into research and development. The engineering departments of motion picture studios did much of the basic research that led to the eventual development of a 33⅓ rpm record made out of an acetate compound.[1]

AFB's Irwin kept abreast of the technological developments going on in the recording industry. In 1924, he was approached by the son of Frank L. Dyer. The senior Dyer had applied for patents on several recording innovations: a speed slower than 78 rpm and grooves narrower and closer together than were then used. In April 1924, Irwin wrote to a friend that there was a "scheme simmering in

which I am tremendously interested . . . for making phonograph records which will contain 15,000 words on one side of a twelve-inch disk."[2] According to Dyer, the records were inexpensive to produce and could be played on an inexpensive record player. The Radio Corporation of America (RCA) had also been working on developing a twelve-inch, 33⅓ rpm record, but apparently had abandoned the project, mainly, according to Irwin, because the pickup arm holding the needle was so heavy that it destroyed the record after several playings.[3]

Dyer's patents were granted in 1927, and in 1932 he offered them royalty free to AFB for use for blind people, with the proviso that his gift be acknowledged publicly. As a result, each talking book produced between 1934 and 1948 was labeled, "Isabelle Archer Dyer Memorial Record." In the meantime, despite Dyer's patent, other record companies had continued work on developing a more closely grooved 33⅓ record. It was to these record companies that AFB turned for help in developing a talking-book record for blind readers. AFB approached Western Electric Company and the Edison Laboratories in 1927 and RCA in 1932. In negotiations with RCA, AFB offered to provide narrators and to coordinate distribution of the records if RCA would manufacture them. All the companies approved of the idea in theory, but because of the lack of any commercial possibilities and, in RCA's case, the expense of using the facilities of a large plant for a run of a hundred or so records, they declined to work with AFB.[4]

AFB was left with no recourse but to attempt to perfect a talking-book record and talking-book machine itself. Armed with an experimental record that demonstrated it was possible to record fifteen minutes of acceptable speech on a twelve-inch record revolving at 33⅓ rpm, AFB officials convinced Frederick A. Keppel of the Carnegie Corporation and a private donor to contribute $15,000 to AFB

to perfect a talking-book record. It was then that Irwin uttered the following prophetic words to Keppel: "I believe that the libraries for the blind of the future will be stocked with phonograph records instead of braille books, and that these records will be loaned through the mail just as braille books are today."[5]

AFB had already hired Jackson O. Kleber, who earlier had worked both for RCA and for Electrical Research Products, a subsidiary of Bell Telephone Laboratories. After hiring Kleber, Irwin wrote Keppel, "We start our investigations right where the RCA Victor and Bell Telephone Labs left off."[6] AFB immediately set up a small laboratory, and work on talking-book technology began.

Records

The long-playing record patented by Dyer provided the principle on which the talking book was based, but many issues remained to be resolved: the material out of which the record was to be made, the size of the record, the speed of the recording, the number of grooves per side, the method of recording, and the type of needle. Because talking books needed to withstand the rigors of being shipped to patrons around the country, the fragile shellac records common in the 1920s would not serve the program's purpose. The material selected was a vinylite compound developed by RCA. This compound was durable, tough, and flexible enough to ship by mail as well as sturdy enough to last through fifty to fifty-seven playings. A thickness of .08 inch was agreed on because at the time that thickness provided both durability and convenience in the press feeding during manufacture.[7] Size was also a key issue. Although thirteen- and fourteen-inch records were considered, the twelve-inch record was chosen because pressing dies were readily available for this size, it was easily handled, and it was the largest size that would easily fit on standard storage shelves.

Speed of recording had also to be decided on. Recording speed, of course, was one of the factors determining how much material could be packed onto a single record, which, in turn, influenced the convenience of listening to a talking book. Records with the current three- to five-minute playing times were not feasible. A number of speeds were considered, but 33⅓ rpm seemed to be a logical choice because commercial recording companies' interest in that speed already had stimulated the production of motors for phonographs capable of playing 33⅓ rpm records.[8]

Another factor influencing the number of words on a record was the pitch, that is, the number of grooves per inch. During the early 1930s, a pitch from 90 to 100 grooves per inch was common. Experimentation revealed, however, that recording at a pitch of 150 grooves per inch could result in good-quality speech reproduction if care were taken to avoid echo or ghost from the modulation in adjacent grooves. The 150 pitch was eventually decided on for the first talking books. Using the 33⅓ speed and the 150 pitch, a 60,000-word book could be recorded on eight or nine twelve-inch discs with a playing time of twelve and a half minutes on each side.[9]

What recording method to use also needed to be resolved. Because people were accustomed to playing records from the outside toward the center, it was decided to record talking-books the same way. This method produced very good sound reproduction on the outside of the record, but the quality fell off as the needle approached the center of the record. Technological advances in the future would relieve the problem.

In a 1934 letter to Herbert Putnam, librarian of Congress, Michael Migel, president of AFB, reviewed the foundation's governing principles in developing materials: "The requirements set up for the record were economy of manufacture, high quality of reproduction, and a durability sufficient

to stand up under circulating library usage. The requirements for the reproducer were economy of manufacture, simplicity of operation, and adaptability to the needs of the blind reader." Migel noted that AFB had intensively studied ways of applying the most improved methods of sound recording to materials produced for the blind. Stressing the eclectic nature of the field, Migel wrote, "This is an art which in a measure overlaps several fields, including the radio, talking pictures, and the telephone; and various research laboratories, as well as individual inventors, are working continually to bring to light devices and improvements which may conceivably have a bearing on the Talking Book."[10]

Migel described two ways of recording on phonograph discs, the "standard" lateral method, the method used by all commercial companies, and the constant linear velocity method. In the former method, the disc turns at a uniform number of revolutions per minute while the speed at which the record passes under the needle constantly changes as the needle travels from the periphery to the center of the disc. In the constant linear velocity method, the record passes under the needle at a uniform number of inches per second through the entire disc; this method requires a constant change in the number of revolutions per minute at which the record turns. By selecting the recording method used by commercial firms, Migel felt that the talking book project would be in a position to benefit from future research carried on by commercial manufacturers.[11]

AFB's decision on this matter, however, was challenged by the proponents of a constant linear velocity machine called the Readaphone, which had been produced for J. Robert Atkinson, managing director of the Braille Institute of America. Before AFB committed the talking-book program to the lateral recording technique, Atkinson suggested that the constant linear method be investigated more

thoroughly. Accordingly, in June 1934, the Readaphone was demonstrated before a group of engineers from RCA, Bell Laboratories, and several other concerns. The group unanimously agreed that the Readaphone was not sufficiently dependable for use in the program, and therefore the constant rpm (variable linear velocity) technique continued to be used.[12]

By June 1937, the Project, Books for the Adult Blind, had distributed approximately 145 books (16,700 containers of talking books). The number of books produced lagged considerably behind the number of machines issued, however; by that date, approximately 16,200 machines had been distributed to blind readers. An additional $100,000 appropriation in fiscal 1938 brought the total annual funding to $175,000 and allowed an additional 250 books to be produced in 1938. In the same year, American Printing House for the Blind (APH) began producing records for the talking-book project. APH's decision to produce records for the project was welcomed both by the Library of Congress and by AFB, which was unable to meet the demand for records. With the prospect of a second producer, however, it was thought necessary to draw up specifications to ensure the uniformity and quality of the recordings.

In December 1937, shortly before APH entered the program, new specifications were drawn up. The specifications listed the twelve-inch size of the record, the 33⅓ rpm recording speed, the use of the lateral cut recording method, and the standard recording pitch of 150 grooves per inch. The specifications also required a spiral lead-in groove, which made it possible for a reader to begin a record with the needle resting on the disc before starting the turntable. The lead-in groove, which had been part of the original design of the record, is illustrative of the talking-book program's attempt to customize its material for the blind reader. The record specifications that were drawn

Early talking books were shipped in sturdy cardboard containers.

up in late 1937 continued to be used, with but slight modifications, throughout the war years.

AFB also had to devise mailing containers for talking-book records. To protect records from

breakage, they were mailed in sturdy cardboard containers that could hold up to twenty-two records each; many containers weighed as much as twelve pounds. A book such as *Gone with the Wind,* which was recorded on eighty records, required four containers! Each record container had two identifying labels, one in print for the dispensing librarian and one in braille for the reader.

The years from 1932 to 1945 saw great strides in the development of the talking-book record. Because of the persistence of a group of dedicated individuals, Irwin's dream that libraries for blind readers would one day be stocked with phonograph records was on its way to becoming reality.

Talking-Book Machines

There was still another major hurdle to be overcome before the talking-book program could get underway: development of a satisfactory talking-book record player. Because standard phonographs played only 78-rpm records, AFB, using parts developed for commercial studios, designed special machines that could also play 33⅓ records. In effect, blind persons got the long-playing record fourteen years before it was available commercially! Both an electric and a spring-driven (hand-cranked) machine were produced. By April 17, 1935, responding to the congressional mandate that machines be in the hands of patrons before the talking-book project got underway, AFB had raised money to produce approximately 2,200 talking-book machines. Prior to 1935, AFB had sold machines to certified patrons, and charitable groups had raised money to buy and distribute machines to blind persons who could not afford to purchase them.

The original talking-book machine developed by AFB weighed about thirty pounds and measured fifteen inches square by eleven inches deep. The machine, originally called a talking-book repro-

One of the earliest talking-book machines and record.

ducer, was built with parts adapted from those available from commercial manufacturers and ran on an AC/DC motor. The reproducer was equipped with controls that made possible variation in speed, tone, and volume. The case could be closed and the machine carried as a suitcase. The machine was produced in quantities for approximately $30 apiece; a nonelectric, spring-driven machine was constructed at a cost of approximately $20 each.[13]

By the 1930s, the country was in the throes of the depression, and AFB, recognizing that many people would not be able to purchase machines, conceived the idea of having machines built as a

Works Progress Administration (WPA) project. The foundation enlisted the aid of Helen Keller, and Migel wrote to President Roosevelt asking for his support. According to the regulations of the Works Progress Administration, a federal project had to be sponsored by a federal government agency, so the foundation suggested that the machines be built under the auspices of the Library of Congress, and then be sent to state commissions of the blind for distribution to blind people. After a meeting with Keller and Migel, President Roosevelt "personally expedited" the plan of having talking books manufactured as a work relief project. The Library of Congress agreed to the proposal, albeit somewhat reluctantly because ownership and distribution of record players seemed inappropriate functions for a scholarly institution.[14] When AFB offered to handle all details connected with the distribution of the machines, however, the library agreed to the plan and designated the foundation its agent in the works relief project. Funds for the manufacture of machines were transferred to the Library of Congress in September of 1935; a few months later, in December of 1935, a shop was set up in Manhattan under the direction of a group of men from the foundation's talking-book machine shop. Because the project was a WPA project, the shop's employees were the unemployed, usually white-collar workers, who lacked a technical background. Under the direction of a skilled and enthusiastic supervisory crew, however, they soon became very productive. The spirit of the project is suggested by an observation by New York Congressman Matthew J. Merritt:

> My first impressions . . . were those of simplicity, energy, and good management. There are 300 men working on one large floor. . . . It is impossible to doubt that every one of these men derives his inspiration from the sign which hangs at one end of the room. It reads, "Every man

> working here is doing his part to make the blind of the country happier." There is adequate evidence of this in the cheerfulness and energy which these W.P.A. men apply to their work.[15]

Initially, the WPA project manufactured only electric talking-book machines; later on, however, in response to popular demand, several thousand spring-driven machines were also produced. During the period of the WPA project and for several years thereafter, AFB continued to produce machines for sale to individuals. During this time, various improvements were made. In 1938, for example, an AC motor replaced the original AC/DC motor, and a new pickup tone arm was introduced. The new pickup arm, which was constructed completely at the WPA plant, was lighter, weighing almost 50 percent less, and more sturdily constructed than the original arm, which had been purchased from a commercial firm.[16] Because the lighter arm reduced record wear, seven thousand replacement arms were included in the 1940 fiscal year budget; they were scheduled to gradually replace the arms in the older machines.

A WPA report for fiscal year 1940-41 reflected a continuing attempt to improve the talking-book machine. The report noted that the US 189-B machine currently being produced included a device aimed at reducing resonance in the pickup arm and that for fiscal 1942, the amplifier circuit had been revised to provide an extended frequency range with reduced distortion.[17] A new method of anchoring pickup leads was also developed, resulting in more rigidity and simpler repairs.

Needles, an essential and often troublesome part of the talking-book program, were also handled by the WPA project after fiscal 1938. The project bought needles in bulk, and visually handicapped workers counted them into packets of forty. The needles were then shipped to lending agencies, which included a packet with each shipment to a

patron. Needles were in great demand because a reader needed either to use a high-quality needle or to insert a new needle for each side of a disc. In fiscal 1939 and 1940, the project sent out 33 million needles.[18]

Machine repair was another function gradually assumed by the WPA project. Because no new machines were produced during World War II, machine repair was crucial. The need for repair work was dramatized by letters from both libraries and patrons, who testified to the inability of local repairmen to repair talking-book machines. The following letter sent to the project by a home teacher for the blind at the Lighthouse of the Blind in El Paso, Texas, is typical: "We have two machines here now in need of repair. Two local radio men have worked on one of the machines at a cost of six dollars to the blind borrower, and I fear the machine is in worse condition now than it was before these efforts at repair. If you have any facilities for repairing machines in the near future, will you please advise me IMMEDIATELY."[19] The problem was to get worse before it got better.

The WPA project closed down on June 30, 1942, because the Works Progress Administration was phased out. Since its opening in 1935, the plant had produced or distributed 23,505 talking-book machines (20,505 electric; 3,000 spring-driven), 7,000 pickup arms, 69.5 million needles, 130,000 record envelopes, 40,500 record containers, and an unspecified number of replacement parts.[20] Although no machines were manufactured during World War II, libraries received new machines from stock, and the old machines, a number of them dating from 1935, continued to be used.

Discontinuing the WPA project meant stopping not only machine manufacture but also machine repair. Because it was essential to keep the old machines in use, an act of Congress, approved

in October 1942, added $20,000 earmarked for machine repair to the talking-book project for fiscal 1943. The money was very welcome. During 1942, the number of readers had dropped by a thousand, mainly because of the worsening machine shortage. AFB was awarded a contract, under competitive bidding, for machine repair and in January 1943 began repair of library-owned machines. Responsibility for repairs remained with AFB until the end of the war.

Reader samples book using Model R playback machine.

The Postwar Years: 1946-1958

Between the years 1939 and 1946, under the leadership of Archibald MacLeish, who was appointed Librarian of Congress in 1939, the library reorganized. In 1941, the Reference Department was established, and the Division of Books for the Adult Blind was made a part of it, as was the Library of Congress regional library for the blind. After several years under part-time administrators, the division was assigned a full-time director, Xenophon P. Smith, in January 1946. Observing that library services for blind individuals were "scattered within the Library of Congress and locally where historic accident had dropped them," the new director suggested consolidation of work for the blind at the Library of Congress and at the National Library for the Blind in Washington, D.C., into a single integrated organization.[1] On August 6, 1946, a bill authorizing the division's appropriations to be doubled became law (the funding went from $500,000 to $1,125,000). The suggested consolidation went ahead as planned, and on October 16, 1946, the division was renamed the Division for the Blind. The name change anticipated a basic change that went into effect a number of years later, in 1952, when the word "adult" was deleted from the law, making children eligible for the service.

A reassessment of talking-book equipment, both records and reproducers, took place in the postwar years. The reevaluation was spurred on by the need to supply talking-book materials to servicemen who had been blinded in the war. The division had been supplying talking-book records and machines to rehabilitation centers since 1944, and the talking book had been termed a very effective aid to the rehabilitation of the war-blinded.[2]

A conference on the talking-book machine was held on May 15, 1945, at the Library of Congress to discuss the development of an improved "sound reproducer" for blind readers, with particular reference to war-blinded servicemen and veterans. The conference brought together a number of experts from government agencies, commercial recording companies, and talking-book producers. Among the participants was George W. Corner, chairman of the federal government's Committee on Sensory Devices, Office of Scientific Research and Development. The library had hoped that the committee, which was working on advanced technological mobility and reading aids for blind persons, might work on modernizing talking-book design. Committee members, however, ultimately refused, saying that the "necessary improvements were within the competence of the phonograph industry."[3]

Conference participants noted that no changes had been made in the basic design of the reproducer since its development in 1934 by the American Foundation for the Blind. They also testified that the machines were in frequent need of repair and were wearing out at a rate of about ten per month. A questionnaire distributed to talking-book readers during the mid-1940s had verified that talking-book technology needed improvement. Readers had complained that machines often broke down and could not be repaired locally because they needed nonstandard parts, that a new needle was needed for each playing of a side of a record, and that the needles were hard to change. Patrons had also criticized the tone quality of the reproducer, which lagged behind the tone quality of current commercial players. Additionally, patrons who did not have two-speed (78 rpm and 33⅓ rpm) machines had requested that a new machine be equipped with both speeds to enable readers to play fast-speed commercial recordings.[4]

Responding to the request for better sound quality without sacrificing length of playing time, a conference participant, Peter C. Goldmark, director, Engineering Research and Development Department, Columbia Broadcasting System, suggested narrowing the recording grooves and recording the grooves at 200 lines to the inch rather than 150 lines to the inch. To fit these grooves, a finer needle (.0005 inch) would need to be used, and the recording speed would need to be changed to 40 rpm. At this speed, playing time per side would be eighteen to twenty minutes as opposed to twelve to fifteen minutes. The cost of producing a machine capable of playing 40-rpm records, however, was projected to be around $150, and the fact that more than a million records currently in circulation had been recorded at 33⅓ rpm argued against manufacturing such a machine. It was considered that the finer needle needed for the 40-rpm recording speed would not work well with the wider grooves used in the 33⅓ rpm records.[5]

By the conclusion of the meeting, a list of desirable features for a new machine had been drawn up. Among the recommended new features were a permanent needle, a tone arm that was automatically placed on the record by a push-button control, improved tone quality, an eight-inch speaker enclosed in the back lid of the carrying case to cut down on motor vibrations, standardized parts, and a portable carrying case. The conference members recommended retaining an AC (heavy-duty) motor, preferably with rim drive; a two-speed turntable; a magnetic pickup; and earphone jacks. It was estimated that a portable record player incorporating the suggested improvements could be produced for $50 to $60.[6]

In the spring of 1946, another group of specialists charged with studying the recording and reproducing of talking books was formed. The committee was chaired by Dorman D. Israel, vice

president of engineering and production for Emerson Radio and Phonograph Corporation, who had suggested that a committee was needed to work on standardizing both recording and reproducing talking books. Included among the committee members, in addition to Israel, were representatives from Shure Brothers, Decca Records, Inc., Utah Radio Products, Lincoln Electronic Corporation, the General Industries Company, RCA Victor Division, the Crosley Corporation, the Alliance Manufacturing Company, and American Foundation for the Blind. The committee was charged with writing "specifications which would cover all systems broadly, but, in addition, to prepare performance specifications, standards of good engineering practice and suggested design details for a system which could be currently procured."[7] The committee's interest testifies to the helpfulness of commercial concerns in developing the talking-book program.

Until fiscal 1949, when the National Bureau of Standards was contracted to conduct a program for research, development, and testing, the Division for the Blind had lacked any systematic technical supervision in developing talking-book equipment. AFB had developed specifications for records, needles, and machines from 1935 to 1942. When AFB resumed production in 1946, following the war, the talking-book machine they manufactured followed the specifications of the latest prewar model. Although the Division for the Blind purchased a number of the machines for the talking-book program, the machine clearly needed to be redesigned to take advantage of new technological developments.

In August of 1948, at the suggestion of Xenophon P. Smith, who headed the program at that time, the Division for the Blind began discussions with the National Bureau of Standards about a long-term program aimed at improving talking-book

records and reproducers in light of the recommendations made at the 1945 conference held at the Library. In a letter to E. U. Condon, director of the bureau, the Librarian of Congress, Luther H. Evans, wrote: "Our present specifications for talking-book records and for reproducers, including pickups and needles, are based on pre-war standards. While our product is considered adequate, we are desirous of supplying the blind of this country with the most efficient, modern, and practicable records and sound reproducing apparatus."[8]

Evans requested that the Bureau of Standards write new specifications on the basis of a survey on the talking-book program's needs and of the latest developments in sound-recording technology. The bureau agreed, and suggested that the contract be set up on a continuing basis to ensure that the talking-book program be kept abreast of the latest developments in recording technology. The bureau's proposal identified three components—research, development, and testing—and listed the following areas to be investigated: talking-book reproducers, including components such as tone arms, pickups, loudspeakers, amplifiers, and luggage; talking-book needles; talking-book records; embossed recording; and magnetic recording.[9] The contract with the bureau ran through June 1952, when it was terminated because of the high costs projected for the fiscal 1953 budget.

In July 1953, the library entered into a new research contract, this time with AFB's recently founded Department of Technical Research and Development. Under the contract, AFB was authorized to test items for current and possible future use and to investigate and keep abreast of developments in the commercial recording field. During the two years the contract was in effect, AFB investigated the feasibility of a two-speed turntable for talking-book machines, 16⅔ rpm recordings, compressed speech, two German tape-

and film-recording techniques, and an English cassette talking-book machine. Although initially promising, the German and English inventions did not in the end prove workable. The research group also investigated the feasibility of using a transistor amplifier for spring-driven record players; evaluated and modified specifications for the model B machine; and designed an AC amplifier and a revised case for the model C machine.[10] In general, AFB recommended keeping talking-book machines as simple as possible, aiming for good speech reproduction, keeping costs down by eliminating items of questionable utility, and using high-quality components and the most durable construction possible.[11]

Records:

In talking books, good reproduction is especially important because most of the material is unfamiliar to listeners, who have no easy way of checking their impressions of the words they hear. Because of this fact, talking-book recordings must have higher fidelity than is usual even in good musical recordings. The importance of good fidelity was recognized by both the library and the bureau. A 1949 report on the bureau's work noted that a study of "the effect of frequency range and distortion in reproduced speech, as they affect articulation and ease of listening, is to be undertaken immediately."[12]

Talking-book record specifications had remained virtually unchanged since 1940, and one of the charges to the National Bureau of Standards was to undertake a full-scale evaluation of talking-book records and to write up new specifications ensuring that the records produced by AFB and APH were standardized and of the best physical and acoustical quality possible. To this end, arrangements were made with AFB and APH to study their recording techniques and both groups produced test records. The bureau also was charged

with getting rid of the distortion in the inner circle of talking-book discs, something that had been a problem for years.

Because there were no established methods for testing speech records, the bureau was forced to develop a new technique for studying speech communication systems. The new technique, which was developed by Edith Corliss and other bureau staff members, used a commercial spectrograph known as a Panoramic Analyzer, which had been modified to enable it to display all of the frequencies present in a speech sample.[13] The resulting integrated spectrogram of the human voice was then compared with the integrated spectrogram of a sweep-frequency test record through use of a simple optical procedure developed by German researchers. The bureau's testing method allowed direct observation of the location and relative magnitudes of the peak frequencies making up speech sounds. The method also allowed the modifications in the speech sounds produced by either the recording process or the reproducer to be determined with some precision. On a disc recording, the high-frequency groove modulation is very small in size. As a result, the intensities of some of the higher frequencies tend to be reduced, impairing the distinguishability of certain consonant sounds. To provide data for improved specifications for talking-book records, studies were carried out to determine what had to be done to maintain high-frequency fidelity in the inner radii of talking-book discs.[14]

After a considerable amount of work on record wear and a study of the most appropriate acoustic and record characteristics, the bureau wrote interim specifications in 1951. The library had hoped to convert from the currently used U-shaped groove record with 155 lines per inch to a V-shaped microgroove record with 240 lines per inch, but the bureau reported that needles compatible with the current stock of records would break

down the walls of the microgroove records. Accordingly, the interim specifications provided for a modified V-shaped groove that was cut at 155 lines per inch and would accept either a 1.0-mil microgroove needle or the currently used 1.8-mil needle.[15] A full microgroove system was adopted in fiscal 1953.

The scope of the bureau's proposed work on records is suggested by the list of items included in the bureau's final report on record investigation. The list included studying the equalization characteristics needed to maintain maximum high-frequency response on the inner radii of talking-book records, studying and suggesting modification of the depth of V-shaped grooves to lessen record wear, investigating methods for making replicas of the grooves on existing records for the purposes of studying record wear, studying plastic recovery in vinyl pressings produced by AFB, and studying compliancy of the playback cartridge and pivoting of the tone arm to reduce record wear.[16] Much of the proposed work on records was still incomplete when the library's contract with the bureau was terminated in June 1952.

Around the time that the interim record specifications were issued in 1951, AFB and APH discarded their direct microphone-to-wax-master method of recording in favor of the tape-and-lacquer method. In the latter method, readers recorded talking books on magnetic tape, a system which allowed for editing and correcting. When the tape was perfect, it was transferred to a lacquer master. Under the wax-master method, a mistake necessitates throwing out the wax master. In addition, the wax master from which the rigid discs are pressed is destroyed in manufacture, which means that a new recording has to be made to replace worn-out discs. Tapes, in contrast, are easy to store and can easily be reused to produce additional discs or tape cassettes as needed. AFB reported

AFB technician checks lacquer master disc.

Master disc is sprayed with silver nitrate and plates peeled off.

Discs are pressed from plates.

that under the new method, mistakes were cut by 40 percent and narrators' productivity was almost doubled.[17]

In 1953, the library entered into a two-year agreement with AFB's new Department of Technical Research and Development to continue research on talking-book machines and records. For a number of years, AFB had been experimenting with slower recording speeds. Under the contract with the library, such work continued. Early in the 1950s, it was determined that 16⅔ rpm was a feasible recording speed, but before this speed could be adopted, the recording level had to be halved and machine amplifiers had to be able to provide twice the gains of the amplifiers currently in use. The 16⅔ rpm speed was finally adopted in fiscal year 1959.

Research on slower recording speeds continued at AFB, and in 1956 the foundation subcontracted with Peter Goldmark, then president of CBS Laboratories in New York, to develop an 8⅓ rpm, seven-inch, fine-groove record that could play for a total of four hours, two hours on each side. The record had approximately 650 grooves per inch and used a stylus of .25-mil radius and approximately 21-gram force. The frequency response of the record extended to approximately 5,000 cycles, which made it suitable for speech.[18]

After testing a prototype of this record, analyzing the costs involved in production, and taking into consideration that the record was not compatible with current talking-book reproducers, AFB decided not to continue work on the new invention. Goldmark's invention had been a spin-off from his work in developing the seven-inch, 16⅔ rpm automobile record, which was introduced by Chrysler in 1956. That record was able to carry up to forty-five minutes of music or one hour of speech on each side.[19] Two years later, in 1958, Goldmark, who at the time was serving as a consultant to Recording for the Blind, introduced a design for a

very lightweight record player compatible with the 8⅓ rpm record he had developed for AFB and unsuccessfully attempted to interest the library in his new invention. In *Maverick Inventor: My Turbulent Years at CBS*, Goldmark mentioned that the record player he had developed for talking books used the tone arm that had been used in Chrysler's record player. He went on to comment that the tone arm could be "pummeled around a bit without distorting the sound."[20]

Meanwhile, also in 1958, AFB announced that it had developed an 8⅓ rpm record that was compatible with the talking-book machines already in use. It was decided, however, to postpone such a radical change given how rapidly technology was developing. Instead, the 16⅔ rpm record was introduced in fiscal year 1959, with experimental recordings of John Gunther's *Inside Russia Today* on nine-inch embossed discs and *San Francisco Bay* on twelve-inch pressed discs. The slower speed meant that twice as much material could be recorded on a disc, a great boon to the reader and a great monetary savings for the library.

At the end of the 1950s, the talking-book program was beginning to reflect the results of rapid technological developments, which promised to be even more exciting in the future. The basic 33⅓ rpm, twelve-inch book record, which had remained virtually unchanged since 1940, had given way to the 16⅔ rpm disc in the late 1950s. Size, too, was being experimented with. In an effort to reduce the size and weight of the talking book, AFB, for example, had produced several experimental ten-inch discs for the library during the late 1940s and 1950s.[21] And in the next decade, a lighter, more compact disc with an increased playing time would be introduced.

Talking-Book Machines

The Bureau of Standards began its work in 1948 by writing interim specifications for talking-book phonographs. The model R machine, which was

Robert Irwin of AFB with 1940s talking-book machine.

built according to the interim specifications, was smaller and lighter than its predecessors, played both ten-inch and twelve-inch records, and came with a semipermanent needle that lasted through approximately forty records.[22] The following year, twelve thousand model S machines were produced according to specifications developed after testing sample machines submitted the preceding year. When the bureau tested the model S machines, however, it found large variations in such characteristics as tip radius of the reproducer needle, tone-arm force, and loudspeaker response. Clearly, a rigorous set of specifications was needed, and these were developed after the problems were discussed at a 1950 conference attended by manufacturers, AFB, the American Printing House for the Blind, the Library, and the bureau. The next talking-book machine, the model T, was the first machine developed according to a rigorous

system of specifications. A number of the machines submitted in response to the invitation-to-bid issued in fiscal 1950 adhered to the specifications fully.[23] The machine that was chosen for production, the model T, had especially good acoustical quality.

Peter Meisinger, chief engineer for U.S. Recording, which produced the model T, was very much concerned with the tone quality of talking-book machines. Because blind people often listened to recordings for hours at a time, it seemed especially important that listening to the machines not be fatiguing. Articulation was also important because poor low-frequency response makes it difficult for the listener to pick up *p* and *t* sounds, and inadequate high-frequency response makes picking up sibilants difficult. The acoustical specifications of the T machine were very demanding. According to Meisinger, the frequency response of the model T was better than is found in most high-fidelity equipment within the mid-range. He considered the machine a real breakthrough in sound quality.

The model T specifications also demanded a ninety-five-decibel output, which was above the average sound pressure level. To meet this requirement, Meisinger tried some innovations. For example, he used a speaker with a tone resonance around 60 hertz and built an amplifier that started cutting in just above 150 hertz. The end result was a player that could be played at full volume without any trace of turntable feedback.[24]

In order to meet the specifications for the T machine, Meisinger bought a microphone of the type used by the bureau in its testing program and made free-field measurements of loudspeaker response characteristics in his front yard. Once he had tailored the amplifier to the speaker's response, the machine was able to meet the specifications with "full gain and no trace of feedback." The sound was "very stable, very beautiful"; music sounded "just gorgeous" on the machine, Meisinger recalls.[25]

In order to test the T machine, the National Bureau of Standards had developed a sweep-frequency record that glided the audio spectrum from 150 cycles to 5,000 cycles. By putting the record on the player being tested in the bureau's free-field room and placing a microphone in front of the machine, engineers could test the entire system.[26] The circuits had low-frequency cutoffs to prevent feedback. The National Bureau of Standards also examined every component to make sure it was operating well below its stated stress levels. For example, if a machine had a 50-volt capacitor, it could not be operated on 50 volts; it had to be operated with a safety margin. Most engineering laboratories' standard meters were not sufficiently accurate to make sure that all the components met the specifications, but the bureau's meters were. Such testing built a level of reliability into the talking-book machine that had not been present before.[27]

Since 1948, the Bureau of Standards had also been testing talking-book needles because of the damage being done to records by the needles currently in use, which did not always meet specifications. In 1950, as a result of bureau testing, the Division for the Blind adopted a semipermanent needle with a 1.8-mil tip and a predicted life of about 100 hours (or 500 plays) on average 12-inch talking-book records. This figure was a conservative one, and the specifications, in fact, required that the needle be capable of playing 200 hours without damaging records.[28] The model T machine was equipped with the 1.8-mil radius needle.

The division's next reproducer, the model A machine, was produced in fiscal 1951 according to somewhat revised bureau specifications and was expected to give improved performance. The prototype model had performed beautifully. Acoustic testing of the production units by the bureau, however, revealed an unacceptable degree of nonlinear

distortion and mechanical feedback. Apparently, in the production stage of manufacture, a loudspeaker with a different design had been substituted for the speaker used in the prototype. Aware of the potential for loudspeaker-introduced distortion problems in talking-book reproducers, the bureau had, in fact, researched improved loudspeaker housing and mountings that would help alleviate the problem. The bureau had planned to provide loudspeaker design rather than performance specifications for the machines to be produced in 1952.[29] However, because of the deficiencies discovered in the production units of the model A, no new machines were produced. The year was spent investigating and testing. The division finally purchased 7,500 model A machines at a reduced cost and distributed them in 1953.

The division's subsequent talking-book machines, models B, C, and D, were built by a non-profit manufacturer, the Pennsylvania Association for the Blind, under the guidance of T. A. Benham, the chairman of the board of the association. Everyone on the assembly line at the association was blind except for the foreman. The B machines incorporated results of the bureau's research on adapting talking-book reproducers to play Soundscriber embossed discs. An embossed recording is made by pressing a stylus on a moving blank disc made of especially pliable vinyl plastic; in the process, the stylus deforms the surface over which it rides. In embossing, unlike in the standard record-cutting technique, no material is removed from the groove. Embossed records hence usually have shallow, narrow grooves and a limited frequency range, a factor that affects the intelligibility of unfamiliar words in the recording. In addition, the plastic used in the embossing process tends to return to its original form. This recovery process smooths out both high sibilants and low-level, low-frequency sounds, increasing the intelligibility prob-

lems. The embossed recording program was at first mainly directed toward blind veterans, who were issued Soundscriber embossing machines, equipment similar to dictating machines, in order to have textbooks recorded (the Soundscriber machine was the only embossing machine making recordings at the 33⅓ rpm speed used by talking books). The program spread to other blind students, however, and also involved volunteer groups, who made their recordings on embossed discs using similar equipment. Because of the popularity of the program, the library adapted the model B machine to play Soundscriber embossed discs as well as regular talking-book records. The experiment was not very successful, however, and after an initial run of a thousand machines, the library modified the model B machine to make it more suitable for use with standard talking-book records.[30]

The model B incorporated a number of changes from the previous model. The machine used a transformerless amplifier, in an effort to achieve lower costs and improved reliability, and a ceramic pickup, which performed better than a crystal cartridge in hot and damp climates. When the model B machine had been evaluated by AFB's Department of Technical Research and Development in 1954 under the department's research and development contract with the library, engineers reported that the reproducer was capable of playing talking-book records with satisfactory quality at low volume levels but not at high volume levels. Tests also had revealed that the model B machine wore out records quickly and was subject to damage during operation.[31] The library assigned the AFB research department the task of working out design modifications for the model B machine. Subsequent runs of the machine used a curved tone arm to minimize tracking errors. In addition, the tone-arm holding clip was changed to a permanent magnet, which experiments had shown was much easier for blind

readers to use, and a counterbalance was used to lighten needle pressure.[32]

The model C machine, which came out in 1956, retained the majority of the model B features. In an attempt to obtain less distortion for equivalent power output, however, an AC transformer-type amplifier was substituted for the transformerless amplifier of the B model, and the case was redesigned to prevent the resonance problems found in the B machine.[33]

The final machine issued in the postwar period, the model D machine, was designed by AFB under its contract with the library. First issued in 1957, the D model and its subsequent versions—the AD versions produced through 1964—had two-speed motors to accommodate records at 33⅓ and 16⅔ rpm and incorporated refinements developed by AFB's research department.

Model A, left; Model 30,000, right

Model 30,000, left; Model A, right

Mechanical components were not the only aspects of talking-book machines coming under scrutiny by the National Bureau of Standards and AFB's research and development department. Talking-book case construction was also investigated. As AFB had discovered in testing the B machine, case design affects sound reproduction; in addition, durability of case construction is essential to protect machines, which in the past occasionally had been damaged in transit. During its study of case durability, the bureau tested two representative samples of the model 30,000 machine case produced in 1947 and the model A machine case produced in 1951. Both were of the hand-luggage type, constructed of 3-ply plywood, and covered with plastic-coated cloth. The tests revealed that neither case provided as much protection as that offered by several representative samples of commercially available hand luggage that appeared to be adaptable for talking-book reproducer cases.[34] The

bureau made recommendations to the division based on their studies.

Throughout the years from 1946 to 1958, the library attempted to meet the needs of its patrons, working first through the National Bureau of Standards and then through contracts with private firms, most notably the American Foundation for the Blind and the American Printing House for the Blind. Developments in the commercial recording field were closely followed, and engineers worked diligently to produce a talking-book machine that was easy to use, provided good reproduction of the human voice, and was economically feasible to manufacture.

Student uses open-reel talking book.

New Directions: 1959-1970

The period from 1959 through 1970 saw expansion of library services and technical innovations. On October 9, 1962, the Pratt-Smoot Act was amended to authorize "a library of musical scores, instructional texts, and other specialized materials. . . ." The major expansion of services, however, was initiated on July 30, 1966, when President Lyndon Johnson signed a bill amending the Pratt-Smoot Act to extend service to physically handicapped persons who could not use conventional printed material. The amendment closely followed the signing of the Library Services and Construction Act (LSCA) Amendments of 1966, which provided funds to help state library agencies establish or improve services for physically handicapped persons, including blind or visually handicapped individuals. As a result of the 1966 legislation, the Division for the Blind was renamed the Library of Congress Division for the Blind and Physically Handicapped, and plans for an expanded regional library system were made. Fourteen new regional libraries were opened within five years, and the division set about expanding its collection and improving procedures.

Talking-book technology was also expanding. Recording on tape was clearly the wave of the future, and in the fall of 1959, the library began circulating books recorded on open-reel magnetic tape as a supplement to the regular talking-book program. During the late 1950s and early 1960s, the library was also investigating prototypes of cartridge-tape player systems for the talking-book program.

In the 1960s, the division also established its own research and development facilities, including an anechoic chamber for checking machine per-

formance. From 1957 on, the technical section of the division had been developing specifications for machines, records, and needles in addition to keeping abreast of developments in the whole field of sound recording. With the new research and development facility, rigid specifications could be written and tested.

Records

The experiments with recording speed and record size carried out in the late 1950s came to fruition in the 1960s. Beginning in spring 1962, all talking books for children were produced on ten-inch discs at 16⅔ rpm, and after January 1963, all talking books were produced in that format. The slower recording speed provided forty-five minutes of playing time per side, reducing the number of discs required for each book. The savings were used to produce additional copies of each book and to add five magazines to the talking-book program. In addition, because of the lighter weight of the record, it was more easily handled by the postal system.

Experimentation with reduced record speed continued, and beginning in 1968, all magazines were recorded at 8⅓ rpm on twelve-inch records. The slower speed provided up to two and a half hours of reading time per disc. Initially, there were some problems with the new speed. Because of the closeness of the grooves, the needle sometimes slipped, and it was difficult for readers to find their place after the needle had been removed. The problems were solved, however, and the library made plans to switch all talking-book recordings to the slower speed as soon as sufficient three-speed machines were available. The shift took place in 1973.

The use of flexible discs for talking books was another innovation of the late 1960s. In 1968, a flexible-disc recording containing the book announcements for each issue was bound into *Talking Book Topics,* NLS's bimonthly listing of new recorded books. The experimental recording proved

Young reader with AD-3 machine

very popular, and by 1970, the flexible-disc insert contained all the information in *Talking Book Topics*. In the meanwhile, the library had contracted with AFB and APH to develop a flexible disc suitable for direct-mail magazines, that is, magazines that were mailed directly from producers to readers and did not need to be returned. The conversion to the direct-mail, flexible-disc format for magazines was to take place in the early 1970s. Research proved that the flexible disc was very sturdy and economical to produce.

Talking-Book Machines

In 1965, the library produced its first three-speed talking-book machine, the AE-1, which operated at 8⅓ rpm in addition to 16⅔ rpm and 33⅓ rpm.

During the following three years, the Telephone Pioneers of America, a volunteer group that had taken over much of the repair of talking-

book machines, installed three-speed motors in many of the earlier two-speed D and AD models.

The AE-1 and subsequent models through AE-4, which was manufactured in 1967, incorporated several innovations. Both the volume and the tone controls, which were of the "twist" variety, contained on-off switches. The volume control switch turned the entire machine on or off, and the tone control affected the motor only. The design allowed the amplifier to warm up before the record began to play and allowed the tone-arm needle to remain in place on the record so that readers would not lose their place if they interrupted their reading in the middle of a record. The machine cabinets were constructed of plywood covered with gray plastic.

The real revolution in the talking-book machine, however, came in 1968, with the manufacture of the AE-5, a sturdy, yet lightweight machine with a transistorized amplifier for increased performance reliability. The AE-5 was equipped with two speakers. Because one of the speakers was in the detachable lid, which could be used as a free-standing speaker, the machine's sound quality was improved. The AE models also featured roller-type controls, which are easier than knobs for physically handicapped persons to operate, and contained a recessed receptacle for the addition of plug-in remote control and speed control attachments. (Earlier talking-book machines could accept only pillowphone and headphone attachments.) The on-off cycle for the machine could be triggered by just a light touch of the remote control unit, and the speed control unit allowed the reader to speed up or slow down recordings to suit his or her own rate of comprehension. The AE-5 was the first machine with a case made of a strong, lightweight, flexible plastic. The AE-5 weighed in at twelve pounds, much less than the thirty-pound 1930s machines. A contemporary observer noted: "With its two-tone blue color and modern shell design,

Reader with AE-6 and accessories.

its aesthetic appeal far surpasses that of its predecessors."[1] Also produced in 1968 was the AE-5A, a battery-operated, two-speed talking-book machine designed for use by overseas patrons.

Another problem addressed during the 1960s was the talking-book needle. Standardization of needles was desperately needed. In 1950, a semi-permanent needle with a 1.8-mil tip radius suitable for playing about 150 hours had been adopted; older AFB machines, however, required use of steel needles, which required replacement after several playings. In order to take advantage of the continuing improvements in needle technology, new needle specifications were written periodically. By fiscal 1958, four different types of needles were used depending on the machine.[2] Finally, in fiscal

Right, Wooden-cased AE-4 with its amplifier; left, plastic-cased AE-6 with its smaller amplifier. Technician holds tiny amplifier of future talking-book machine.

1964, a double stylus with a diamond needle having a 7-mil tip was adopted. The needle played 1,500 hours and reduced wear on records. It continued to be used into the 1980s. Needle standardization has greatly simplified the process of needle replacement.

Tape and Cassette Program: Open-Reel Tapes

Back in the earliest days of the talking-book program, the division had looked at the wire recorder as a possible adjunct to the talking-book player, but had concluded that magnetic wire was expensive and had poor fidelity. Over the years, advances in tape technology rapidly outmoded wire recording.

Ever alert to emerging audio technologies, in 1959 the division began to test the feasibility of

distributing books recorded on open-reel magnetic tape as a supplement to its regular talking-book program. Although only sixty-five patrons participated in the initial field test and only ten taped books were available for listening, the division quickly concluded that open-reel tape was a useful additional format for talking books. Taped books were particularly attractive because volunteer narrators could inexpensively produce tapes using their own recording equipment, allowing the division to provide many talking-book patrons with specialized books that would never be mass-produced on discs.

Since the early 1950s, many of the regional libraries had been acquiring volunteer-produced books recorded on tape to circulate along with the braille and talking books provided by the Library of Congress. Within a year of its successful experimentation with open-reel magnetic tape, the division had a list of thirty books on magnetic tape available for national circulation. By July 1961, the collection had expanded to some 350 master tapes produced by volunteer readers plus approximately 1,200 tapes produced by AFB and APH, including all the master tapes for the discs that had been mass-produced in the preceding three and one-half years.

Because the tapes could be erased and reused, periodicals were particularly well suited for this format. The division made available nine magazines on tape in 1962, and more periodicals, often specialized magazines with limited appeal, were added later. That same year, the division regularly began distributing open-reel submasters to regional libraries for duplication and circulation. These libraries were also encouraged to make available for national duplication any tapes they had acquired locally. By July 1965, the division's tape collection included some 2,400 volunteer-produced books and magazines. In 1966 alone, while the division was producing about 400 talking books on discs, volunteers provided more than 500 masters

for the magnetic-tape book collection. In 1965, the division began publishing taped editions of *Braille Book Review* and *Talking Book Topics.*

Because volunteer narrators donated their labor and used their own recording equipment and patrons used their own commercial tape players, the open-reel tape program did not create any production or repair problems for the division. The agency's primary role was arranging for tapes to be duplicated and distributed. The division also assigned specifically requested books to volunteers, supplying them with the books and sufficient blank tapes.

In 1969-1970, the division attempted to upgrade the quality of tapes being produced by preparing procedures and standards for evaluating volunteer-produced tape masters. Having previously established seven-inch reels holding 1,800 feet of mylar tape recorded at 3¾ inches per second on two tracks as the standard for recording talking books on open-reel tape, the division increased standardization by supplying readers with pretimed 88-minute tapes. The pretimed tapes, in turn, made the regional libraries' task of duplicating tapes far easier. As early as 1965, the division had also begun providing technical assistance to volunteer groups desiring to improve their recording environments.

A major (and insurmountable) problem with using open-reel magnetic tape was the difficulty blind readers had in threading the tapes. Often regional libraries received back containers full of tangled tapes. In order to overcome this problem, in 1968 the division began testing the acceptance of tape cassettes to replace open-reel tapes. The response was enthusiastic, and thereafter the circulation of open-reel tape-recorded books declined. Because of its high fidelity, however, open-reel magnetic tape has continued to be used to record masters, which then are used to produce either discs or cassette tapes for general distribution.

Comparing talking books: the same title on open reel and on early cassettes.

Circulating recordings on open-reel tape was intended from the beginning only to supplement the regular talking-book program, and open-reel tapes never accounted for a major portion of the total circulation. But they did provide an important service to many blind and physically handicapped readers and paved the way for the cassette, which would eventually supersede the disc as the primary format for talking books.

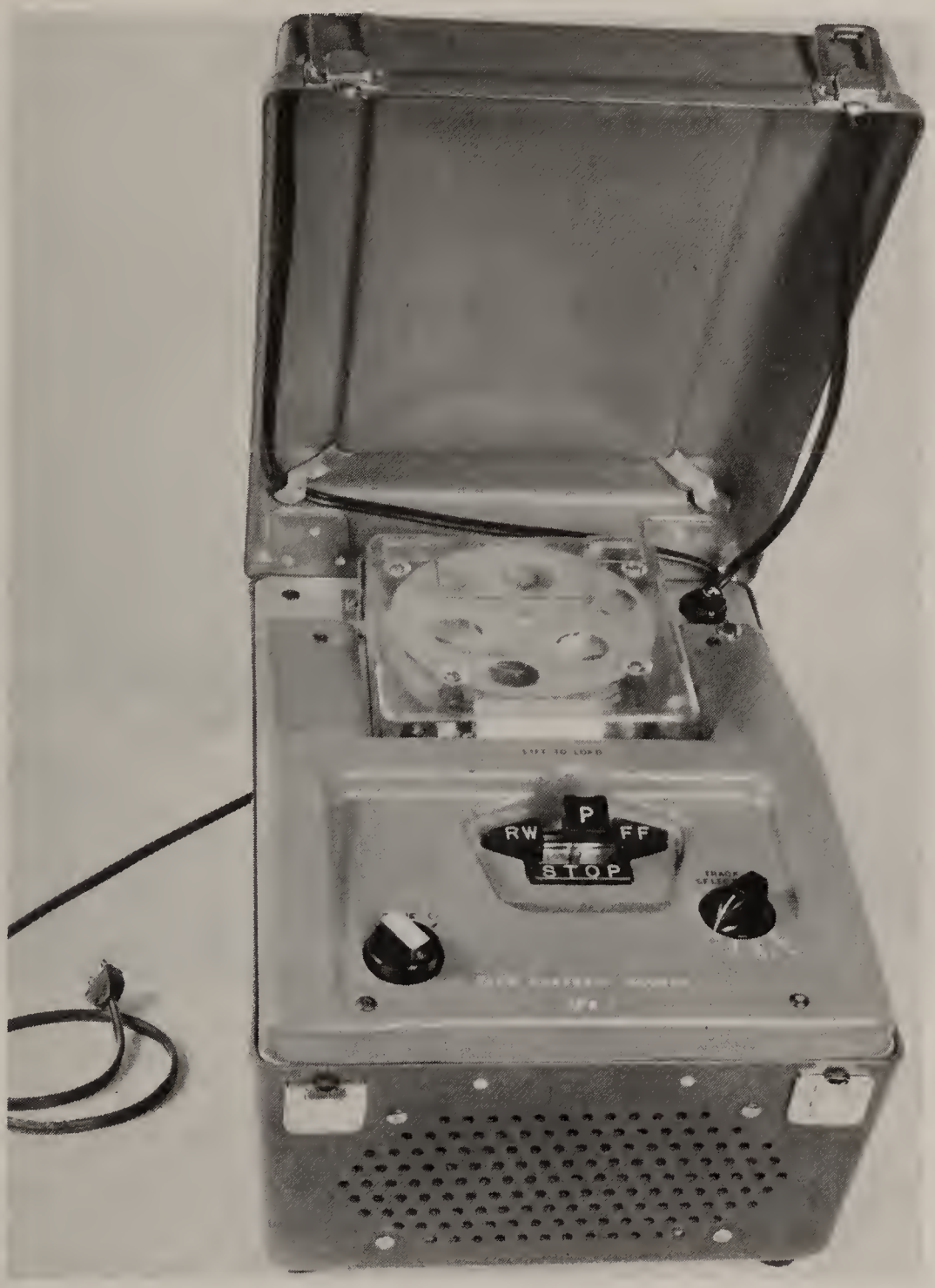
Cassettes and Cassette Players

As early as the late 1950s and early 1960s, even before a proven cartridge (i.e., cassette system) was on the market, the Division for the Blind was negotiating research and development contracts for prototypes of cartridge tape systems that would be suitable for the talking-book program.[3] An encapsulated tape system had obvious advantages over open-reel tape systems because threading tape was difficult or impossible for a large proportion of

talking-book patrons. A cassette's compactness also offered an important advantage over rigid discs.

The division wanted a simple-to-operate, inexpensive, lightweight (preferably portable) cassette machine. In order to avoid copyright infringement problems, the division also wanted a special format that would prevent talking-book tapes from being reproduced and used by noneligible listeners. Consequently, from the outset, specifications were for a two-speed cassette player that would allow the division to provide recorded books at a slower speed than was being used commercially. Besides forestalling possible copyright problems, use of the slower speed would also allow more material on a single tape.[4]

One of the earliest prototypes of a talking-book cartridge player was the Magna Book Mark II. Designed for playback only, the machine weighed approximately twenty-five pounds, and the cartridge—which contained two stacked reels—weighed two pounds and held nine hundred feet of one-mil, quarter-inch tape in a container 6½ inches by 6 inches by 1¾ inches. The machine played tapes at speeds of 1⅞ inches per second (ips) (the standard commercial speed) and 15/16 ips (the division standard proposed for talking-book cassettes). At the slower speed, a single cartridge would offer more than twelve hours of playing time. Moreover, if the cartridge were filled with .5-mil tape, it was anticipated that a single tape would offer up to twenty-five hours of playing time. Other features included fast-rewind and fast-forward capabilities, end-of-tape sensors that would stop the tape before it ran off the reel, a switch to select which of four tracks would be played, an earphone jack for hearing-impaired patrons and for silent listening, and a volume control mechanism.[5] However, technical problems, especially duplication of the unwieldy tapes, persisted, with the result that this system was never manufactured.



Model XPR-1

Another early prototype that was never put into production was the XP-1 (experimental player) and its companion machine, the XPR-1 (experimental player-recorder). The XP-1 played a co-axial reel cassette, consisting of two reels, one above the other, permanently housed in a clear plastic container. The cassette was six by six inches square and one and one-half inches deep. The tape had four tracks and ran back and forth from one reel to the other in the manner of modern tape cassettes. The XP-1 itself measured eleven by fourteen and

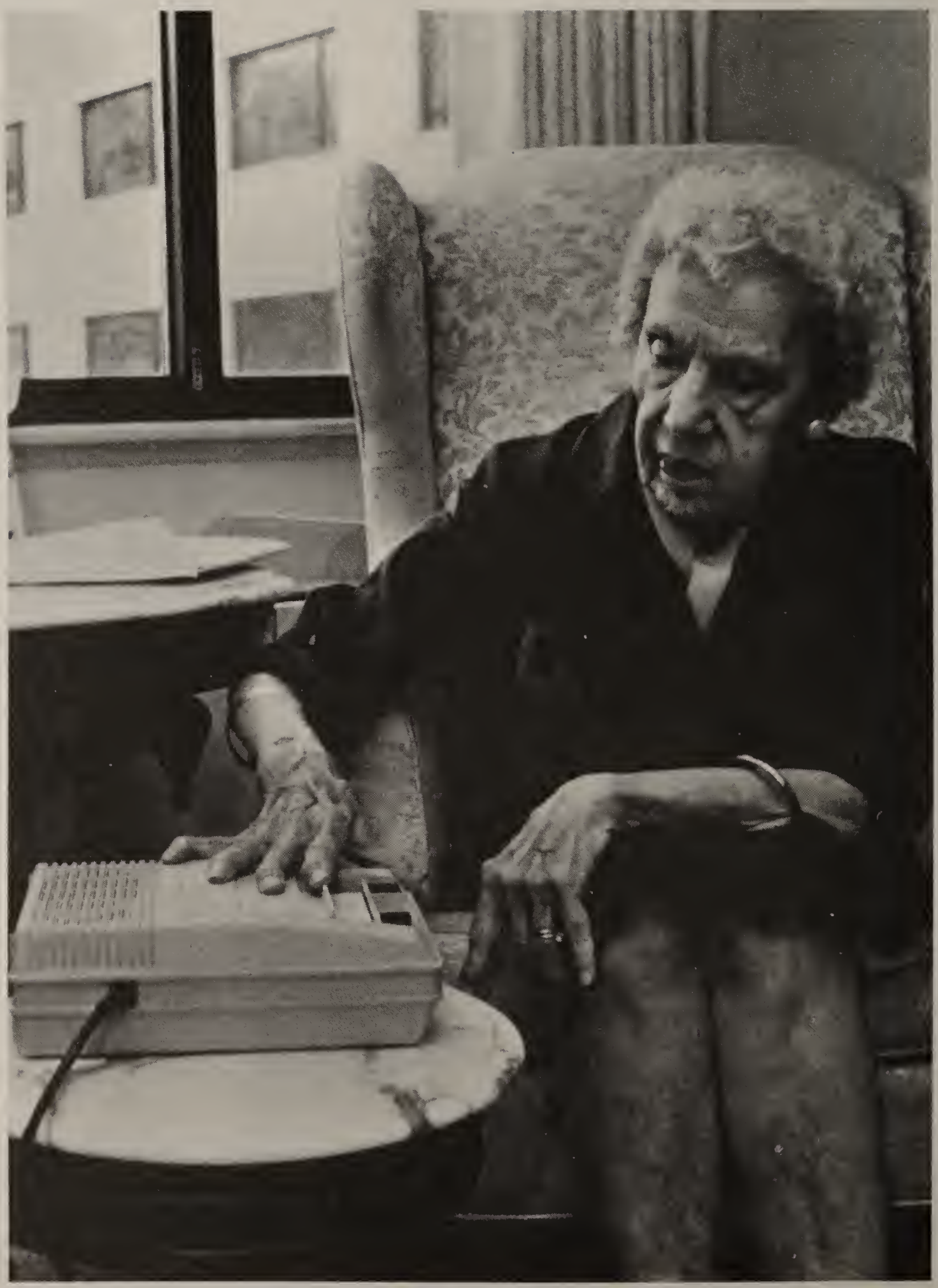
Producers study various designs for tape players.

one-half inches and was eight inches high. It weighed eighteen and one-half pounds and featured differently shaped play, fast forward, reverse, stop, and track selection buttons. The machine played up to twelve hours at 1⅞ ips or twenty-four hours at 15/16 ips and had an "end-of-tape" stop. The Viking Company of Minneapolis, which was acquired by Telex in 1966, produced fifty of these machines for the division between 1965 and 1967, culminating a ten- to fifteen-year development effort. Unfortunately, the prototype was deemed to be overly complex, requiring numerous adjustments for successful operation, and was not put into production.[6]

Meanwhile, by 1968, tape cassettes and players were widely available commercially at a relatively low cost. From among the many incompatible tape systems that had proliferated and com-

peted briefly, the Philips-Norelco-type of compact cassette player had emerged as the market favorite. Abandoning its specially designed prototypes, the Division for the Blind decided to start over with a test of unmodified commercially available cassette players. It bought a total of one thousand cassette players from three manufacturers and distributed the players to talking-book patrons. The division also provided patrons with an initial selection of 150 books on tape (many of them commercially produced) to use in the test. The response was so enthusiastic that the division promptly added cassettes to the talking-book program.[7]

The greater portability of the cassette players and their relatively low cost compared with talking-book machines made them very attractive. In addition, the ease with which volunteers could produce tapes and regional libraries could copy them prompted the division to envision from the outset the time when the entire talking-book program would be on tape rather than on rigid discs.



The E-1 machine was produced in 1987 to meet the needs of the increasing number of older readers with limited manual dexterity.

The Past Two Decades: 1970-1988

During the past twenty years, the talking-book program has sought to keep abreast of the latest technological advances and to incorporate these advances into talking-book equipment whenever feasible. In the early 1970s, the division contracted with several consultant groups to point out trends in technology and suggest the direction in which the talking-book program should go for the next ten years. The groups recommended moving the program into 15/16 ips, four-track cassettes as rapidly as possible and suggested design improvements that would make cassette machines more convenient for blind and handicapped readers to use.[1] In keeping with these recommendations, during the late 1970s and the 1980s, talking-book production has been geared to magnetic-tape reproduction.

A recording studio opened at the division in 1972. At first, volunteers recorded books there, but since 1973, paid staff have done the recording under professional conditions. The studio made possible experiments in recording techniques aimed at improving the overall quality of the recordings used in the program. In 1975, the division also implemented more rigorous quality-control procedures for machine and book production, beginning quality-assurance inspections to verify contractors' compliance with specifications for cassette and disc machines and materials. Failure analysis programs to improve reliability were also introduced.

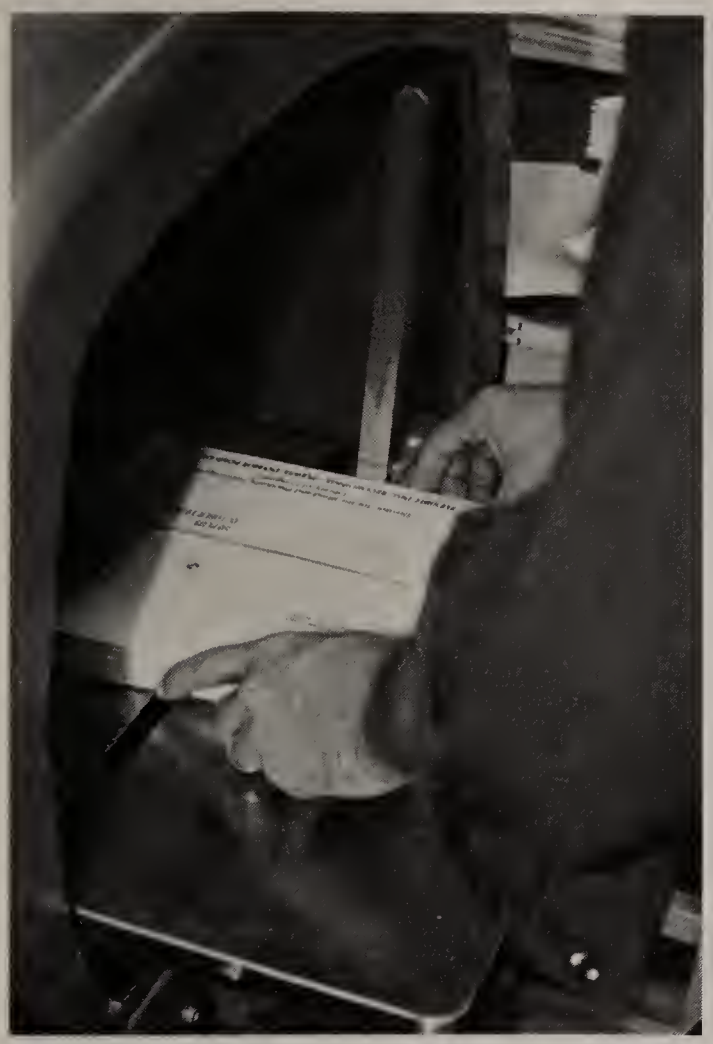
The past two decades have also seen a name change for the talking-book program. Formerly called the Division for the Blind and Physically Handicapped, the program was renamed the National Library Service for the Blind and Physically Handicapped (NLS/BPH) following a Library of Congress reorganization effective June 5, 1978.

Since the late 1970s, magazines have been produced on flexible discs . . .

Records

In the past two decades there have been new developments in disc production. Beginning in January 1973, all talking books were recorded at 8⅓ rpm, making it possible to include almost twice as much material as had been recorded on a disc of corresponding size played at 16⅔ rpm. The slower speed had been a possibility for some time, but the library had been waiting for sufficient three-speed talking-book machines to be in the hands of patrons so that they could play both 16⅔ rpm and 8⅓ rpm recordings.

The flexible-disc format also came into its own during this period. This format had been used experimentally in 1968, with a flexible-disc enclosure in *Talking Book Topics,* and by 1972, three direct-mail magazines on flexible discs were circulated to readers. Magazine conversion to flexible discs was completed in the late 1970s, and as of 1987 all magazines use the direct-mail, flexible-disc



and mailed directly to readers.

format. In 1972, Arthur Hailey's *Wheels* became the first flexible-disc book circulated. Flexible discs are currently being used to record bestsellers and other books that need to get to consumers without a long delay. Such recordings can be produced very quickly and economically, a significant factor when a large and immediate demand is anticipated. The books are later put on cassettes. The last rigid disc book was produced in May 1987. The books that formerly would have been recorded in the rigid-disc format are now being produced on cassette.

The packaging of recorded material for mailing has been another important consideration for the talking-book program. Containers need to provide maximum protection and yet be as light as possible. In the early 1970s the cardboard containers originally used to hold talking-book records gave way to plastic cases, which are both lighter and sturdier than the old containers.

The A-series featured a new design and new capabilites. The A-77 (1977) is shown with early pillow speaker.

Machines: Record Players

The AE machines produced in the late 1960s had been modified to accommodate optional accessories designed to make operation easier for physically handicapped users. The modifications had required several adjustments in machine case design. These changes proved to be but stopgap measures, however, and the A-70 machine, produced in fiscal 1970, was issued with a completely redesigned base that was more stable than the modified AE machine

Workers produce A-80 machines, 1980.

case. Other than for minor refinements, the special features of the machine itself have not changed since 1970. Features of the current model include three operating speeds (8⅓ rpm, 16⅔ rpm, and 33⅓ rpm), an automatic cutoff switch that stops the motor and the turntable at the end of the record, a two-sided needle that can be switched by turning a flip lever, special retractable tab guides that help center the record so that the hole drops onto the spindle, and a detachable lid that contains a speaker that can be set up separately. Optional accessories available for the current talking-book machine include a tone-arm clip, remote control device, breath switch, pillowphone, and auxiliary amplifier.

Cassette Tapes

In 1969, NLS began distributing cassette tapes and tape players throughout the regional library system, and by 1971, *Talking Book Topics* had replaced its open-reel magnetic-tape section with a listing of cassettes. Volunteers initially narrated all the books for the cassette collection, as they had for the open-reel tape collection, and outside organizations duplicated the tapes under contract.[2]

Sir James Hardy (left), vice president of the Royal Blind Society in Burwood, New South Wales, visits NLS to discuss emerging cassette technology with Frank Kurt Cylke, NLS director (right). By 1988, Australia had committed to the four-track, 15/16 ips technology.

In 1974, NLS began duplicating books on two-track cassette tapes at 15/16 ips rather than at the commercial speed of 1⅞ ips. The slower speed allowed more material to be included on a single tape and also made it impossible to play talking-book tapes on commercial machines, thereby preventing possible copyright infringements. In 1977, the division switched from a two-track format to a four-track format. The program's cassette machines had had four-track playback capability since 1973, but duplicating four-track cassettes did not become feasible until 1976. The new format doubled the amount of material per tape. A single cassette can provide up to six hours of playing time, the equivalent of about two hundred pages of text.

A number of problems faced the cassette

program in its early days. A major problem was the inability of APH and AFB to produce enough books to meet demand. Regional libraries also had difficulty duplicating cassettes as fast as they were needed. Moreover, standard measurements of cassette tape length had not yet been established. The library solved this problem first with timing devices and later with pretimed 88-minute tapes. The division also prepared a set of instructions that became the basis for formal specifications for contractors and volunteers alike.[3]

During its early years, the cassette program also had to overcome several mechanical problems.

With 4-track cassettes and sturdy plastic cases, today's talking books are light, easy, and safe to ship.

One such problem, faulty splices between the leader and the tape, caused tapes to break after they had been used a few times, jamming the tape players and discouraging talking-book patrons. Tape spillage also was a problem, and in 1980 NLS conducted a study to determine the cause of the spillage. Using slow-motion photography, investigators determined that the chemical composition of the binder holding the magnetic material to some types of tape was a contributing factor. NLS solved the problem by specifying what type of tape should be used in making talking-book cassettes and devising tests to cull out tape that would cause spillage.

In the 1970s, two studies by outside consultants recommended that NLS convert the talking-book program from rigid discs to cassette tapes and flexible discs over a ten-year period. In keeping with the recommendations, in 1975, NLS began issuing magazines on flexible discs and began gradually phasing out books on rigid discs by reissuing some two to three hundred books per year on cassettes.

By the early 1980s, the cassette was firmly established as the major talking-book format. In 1980, for example, of about 1,700 new books added to the talking-book collection, about three-fourths were on cassette, with the remainder distributed between rigid discs and flexible discs. Also during 1980, NLS selected an additional 2,600 books to be modified to current technical specifications for reissue in cassette format. Cassettes were an attractive format for talking books, not only because of their compactness, low cost, versatility, and ease of handling, but because they could easily be duplicated, thus allowing regional libraries to replace damaged books quickly and easily.

NLS's experiments with cassette recording technology have led to some exciting break-

throughs. One such innovation is the NLS-developed technology of voice indexing, a technology that allows talking books such as reference works to be far more useful than they would be otherwise. Providing blind listeners with meaningful access to recorded materials has always posed a difficult problem because a recorded work cannot be scanned in the way sighted readers scan printed material. In order to locate information efficiently, blind readers of reference books, practical how-to books (including cookbooks), and magazines and collections of stories and poems require some kind of audible indexing system.

The earliest solution to this problem was tone indexing, recording an audible tone at a speed faster than the speed of the text. Once a book was tone indexed, the listener could run the cassette machine in fast-forward and count the beeps through the background noise to find the desired chapter or section of the book. This system was introduced in cassettes in 1972. However, because beeps have no intrinsic meaning, the more beeps there are to count, the less helpful tone indexing becomes. It is totally inadequate, for example, for dictionaries and encyclopedias.

NLS first began experimenting with its present method of voice indexing cassette books in 1978 and came out with its first voice-indexed tape in 1979. Voice indexing is similar to tone indexing except that it uses key words that are audible only in the fast-forward mode. When the reader locates the desired key word, he or she stops the tape and resumes play at normal speed. Voice indexing not only permits many more access points than tone indexing, but also defines these points more clearly.

NLS needed a system of voice indexing that would be easy to use, compatible with existing NLS-provided cassette players, and inexpensive. To meet these requirements, an automatic tape-blending machine for producing indexed cassettes was

developed. The machine blends two separate narrated tapes—one containing the text and indicating where index words are required, and a second tape containing a list of the index words. The machine precisely superimposes the index words over the narrated text at sixteen times the speed of the narrated text. The index words are heard only when the cassette player is in the fast-forward mode. Because the blending of the two tapes can be accomplished very quickly, voice-indexed tapes do not cost much more to produce than other tapes. The same tape-blending machine also compensates for the inevitable variation of speed from the beginning to the end of a tape in the fast-forward mode. Because of the compensation process, a normal-pitched voice is heard throughout the indexing sequence.

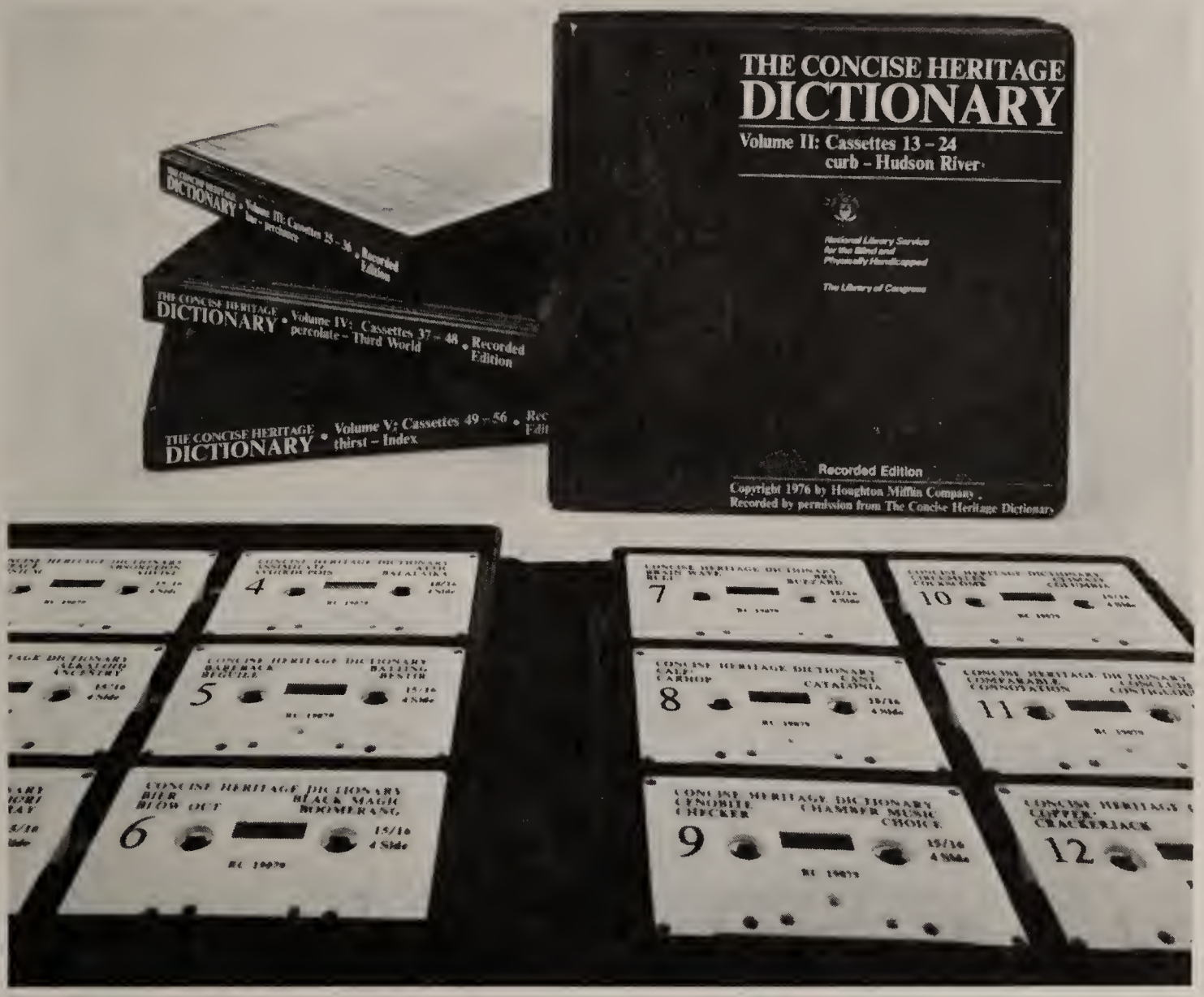
The major impetus behind the voice-indexing experiments and the most ambitious voice-indexing project to date was a much-needed recorded dictionary that would be accessible to blind readers. The successful result was the fifty-six-cassette *Concise Heritage Dictionary*, which, after several years in production, was finally released in 1984. As of that date, NLS had thirty-six voice-indexed tapes either completed or in production.

Machines: Cassette Players

M-Series

Satisfied with its patrons' initial response to books on cassettes in its test with unmodified commercially available cassette players, NLS in 1969 ordered ten thousand commercially available General Electric (GE) cassette players modified to play two speeds ($^{15}/_{16}$ ips in addition to the commercial standard of $1\frac{7}{8}$ ips), adapted for monaural rather than stereo playing, and equipped with machine controls marked with raised characters for ease of operation by blind people. These machines, designated M-8350, were quickly distributed to talking-book patrons.

In 1970, NLS bought fourteen thousand more modified GE cassette players for distribution. Of


THE CONCISE HERITAGE
DICTIONARY
Volume II: Cassettes 13 – 24
curb – Hudson River
National Library Service for the Blind and Physically Handicapped
The Library of Congress
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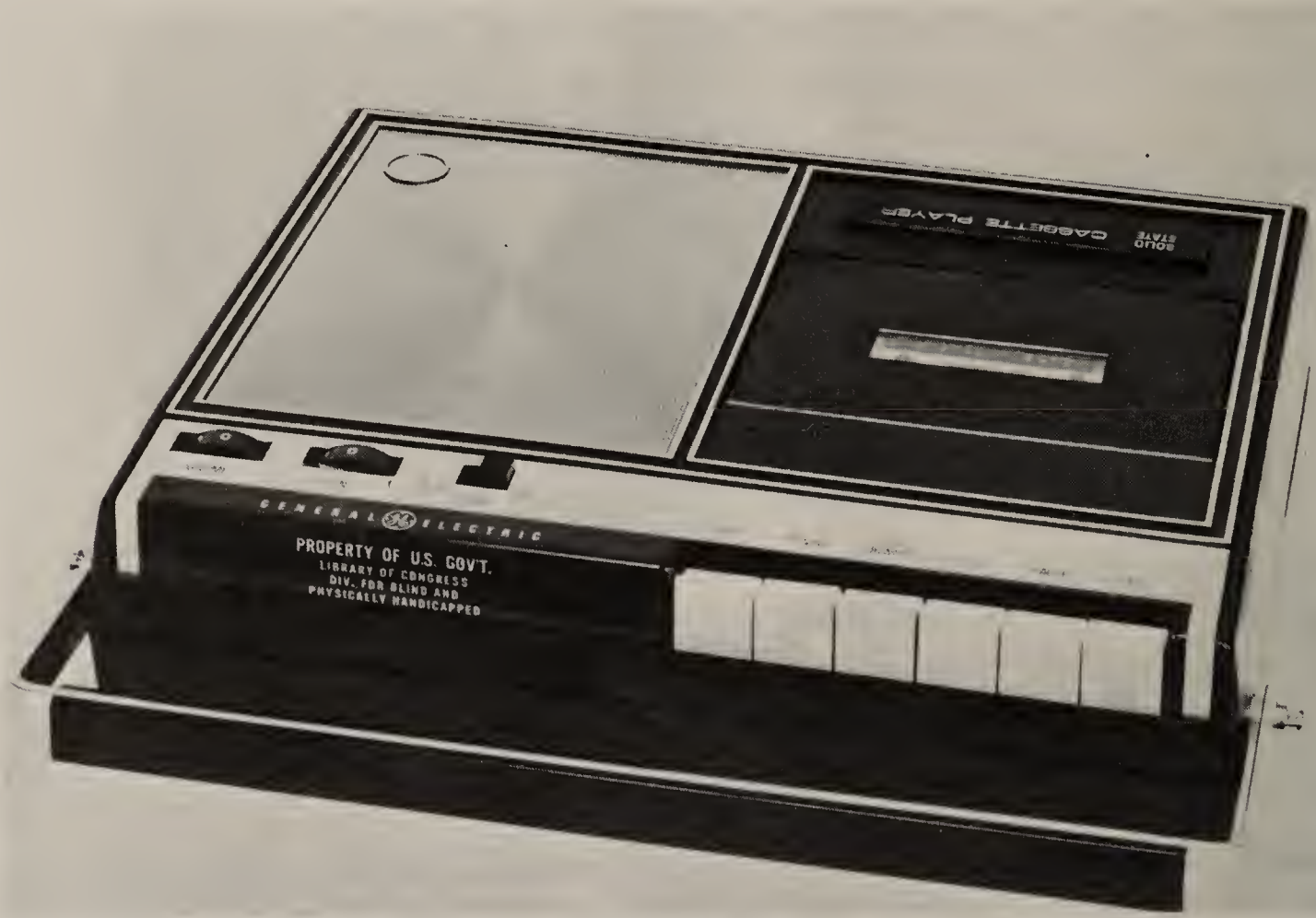
THE CONCISE HERITAGE DICTIONARY • Volume V: Cassettes 49 – 56
thirst – Index

The fifty-six-cassette voice-indexed dictionary was released in 1984.

these, nine thousand were play-only units produced mainly for elderly, institutionalized, and home-bound individuals. The player could be either plugged into an electrical outlet or run off re-chargeable nickel-cadmium batteries. Persons without access to electricity could mail the batteries to their regional libraries or machine-lending agencies to be recharged.[4]

Another five thousand of the machines could both play and record because NLS wanted to supply recording ability to students and other users who needed to record material not otherwise available. However, legal counsel advised that doing so was not in keeping with the law that



The M-8354, a modified commercially available player.

had established the talking-book program. Since that time, no cassette machines provided under the talking-book program have had recording capability.

The demand for cassette players quickly exceeded the supply, and NLS bought an additional fourteen thousand cassette players from GE in 1971. These machines had an added feature that allowed plugging in a variable-speed control mechanism. With this optional accessory, a listener could adjust the speed at which the tape played from about four-fifths normal speed to two and a half times normal speed, thereby approaching normal reading speed, which far exceeds the normal rate of speech. Many listeners who needed to get through material quickly were willing to put up with the high-pitched "Donald Duck" voice that resulted when a tape was played at high speed.

C-Series

In 1972, NLS postponed procuring new cassette machines in favor of purchasing more talking-book disc machines. The following year, the library canceled production of its "ultimate" cassette machine, which had been under development for three years. The all-new machine had been designed by GE based on input from users, regional librarians, and other persons. It was to have had newly stylized cabinetry; improved speakers; modified size, shape, and location of controls; and a built-in speech compression feature for listeners who wanted faster playback capability. But when the prototype was finally ready, it was unceremoniously rejected on the grounds that it was too big.

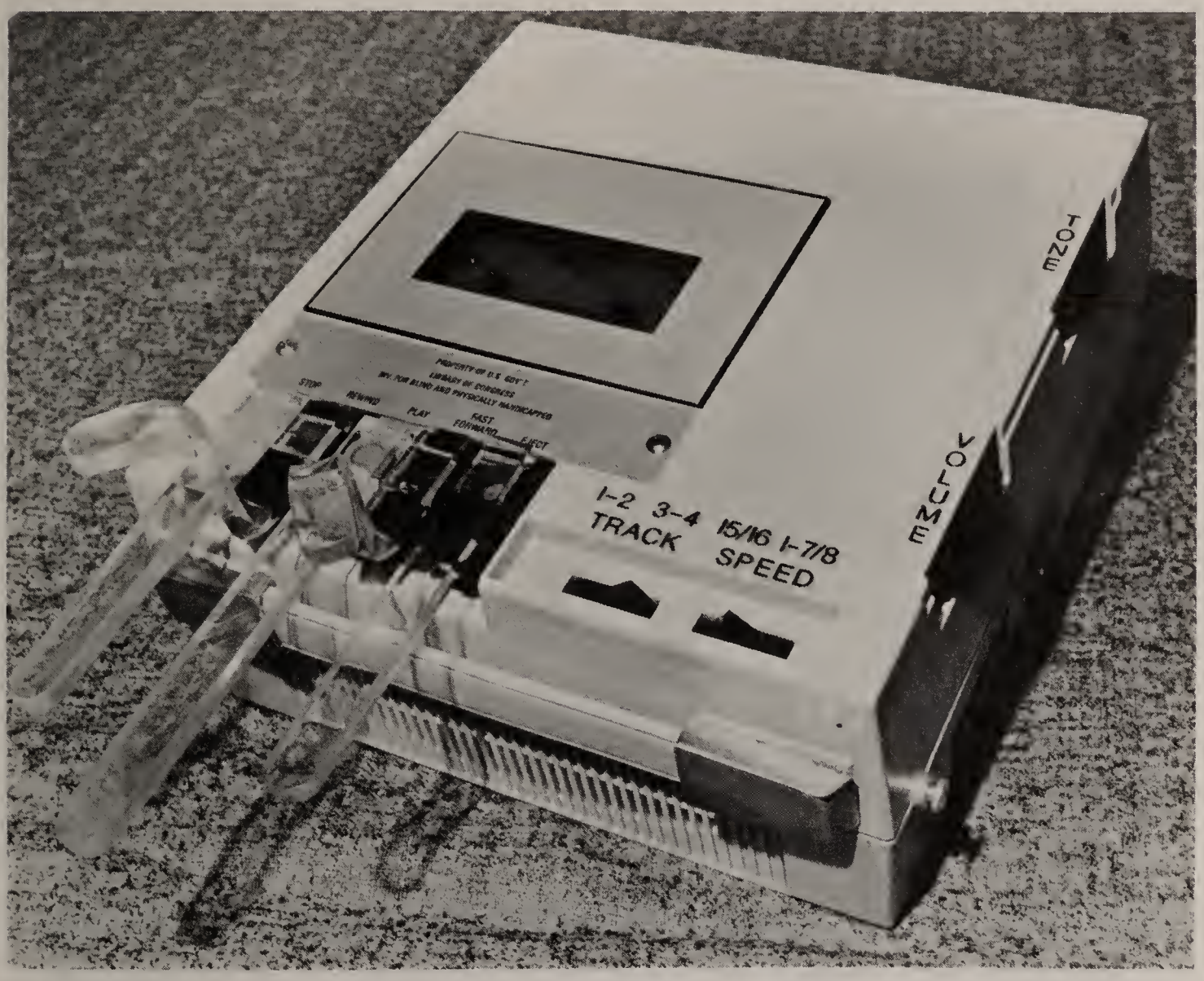
Instead, NLS procured thirty thousand cassette machines built according to scaled-down NLS specifications. Dubbed the C-73, this machine was quite different from the modified GE cassette players that NLS had been providing to its talking-book patrons. It used a four-track system with a built-in track switch, rather than the two-track system used by earlier cassette players. This change meant that a single tape could provide up to six hours of playback—double the amount of time possible with a two-track system. The C-73 could accommodate tone-indexed tapes and had a built-in AC adapter. And like all the cassette machines distributed by NLS previously and subsequently, the machine offered playback speeds of both 1⅞ ips and $^{15}/_{16}$ ips.

In 1974, NLS initiated studies for further improvements to be incorporated into later models—such as an automatic-reverse cassette deck, which was an adaptation of an existing commercial machine. With a four-track cassette, the deck would allow six hours of unattended listening. The proposed deck also included a remote control mechanism, which was already available as an accessory for the talking-book phonograph. However, the size

GE's C-74, an early member of the C-series, used 4-track tapes and played at 1-7/8 ips and at 15/16 ips.

and cost of this deck prevented its production. In 1974, material shortages of electrical components, plastics, and all petroleum derivatives slowed the production of new machines. To meet the immediate need for talking-book machines, NLS redoubled its efforts to repair and bring back into service as many machines as possible of every model. It also bought another ten thousand cassette players from GE, built according to NLS specifications, which it distributed to the network libraries in proportion to the number of readers served by each state.

In 1975, NLS contracted for the production of thirty-seven thousand cassette players that incorporated only minor design changes from the C-73



The C-75, like the C-73, differed from the GE machines. The C-75 is shown here with experimental extension levers.

—such as recessed switches so that a unit that was turned upside down would not turn itself on.

The following year, NLS again ordered a completely redesigned machine based on input from an industrial designer. The new design gave the machine greater aesthetic appeal as well as more reliable performance. This machine, the C-76, was the first talking-book cassette machine to have an automatic shutoff, a tape-motion sensor that would shut off the machine whenever the cassette take-up reel stopped. This feature helped prevent tape spillage, a common cause of broken tapes. The C-76 also had a built-in variable-speed control rather than an external auxiliary speed control attachment

The C-80, which incorporated design features used in cassette players throughout the 1980s, also offered pitch restoration, activated by a small switch on the side of the machine.

for listeners who wanted faster or slower playback capability. Nearly a thousand of these machines were produced and distributed, and NLS for the first time bought the tooling for this machine.

From 1977 to 1979, NLS procured and distributed an additional two hundred thousand cassette machines. The models varied slightly from year to year, but did not introduce any major new features.

In 1980, NLS contracted for thirty-five thousand talking-book cassette players that incorporated a potentially very useful new feature, a built-in pitch restoration feature for use in conjunction with the variable-speed selector switch. The idea was to allow users to play cassettes at fast or slow speeds without a resulting high-pitched "Donald Duck" voice quality or low-pitched drone. The pitch restoration device, which cost about $10 per unit, did adjust the pitch, but it also resulted in considerable sound distortion. To keep the pitch at a normal level, minute segments of the original narration were skipped at regular intervals at fast speeds or elongated at slow speeds. This sampling technique resulted in sound that varied considerably from speech at normal speed. Listeners were advised that their ability to understand a recording using the pitch restoration feature would improve with practice and instructed that adjusting the tone control to higher levels for faster speeds would help them achieve better sound. Nevertheless, the pitch restoration feature was not a great success with talking-book patrons and was not included on later machines, in part because better commercial systems that had become available could be used in conjunction with the NLS-supplied cassette players.

In 1981, NLS contracted for the C-1 machine, which was similar to the previous model except for minor modifications and improvements. The C-1 cassette machine features fast-rewind and fast-forward capacity, end-of-tape sensors, a switch

that allows the reader to select which of the four tracks should be played, an earphone jack, a variable speed control, and tone and volume controls.

The Easy Machine: E-1

In 1977, NLS contracted with the American Foundation for the Blind to conduct a survey of blind and handicapped persons who were eligible to use the talking-book program but did not participate in it. In a report to NLS in 1980, AFB concluded that up to three-fourths of the 3.1 million Americans who were eligible for the talking-book program had serious chronic health conditions (other than those affecting their ability to read conventional print) that could inhibit use of the talking-book program. Many of these people were unable to dial a telephone, much less operate a record or cassette player. The AFB report recommended that NLS make available a cassette player that was easier to operate than the standard models and thus more in keeping with the needs of the very large proportion of eligible patrons who are elderly, frail, or multiply impaired.[5]

Another study performed by an outside consultant in 1979 and reported to NLS in 1981 confirmed the need for a simplified cassette machine as well as for accessory extension levers that would enable patrons with poor manual dexterity to operate the cassette controls. This survey found that 40 percent of talking-book patrons did not have a cassette player, mainly because they felt they could not operate one.[6] By the time the results of the study were in, cassettes were the major format for the talking-book program, and NLS was committed to discontinuing rigid-disc talking books. Thus, NLS concluded that a highly automated cassette machine with a minimum number of controls was needed, especially for elderly users.

NLS began developing a simplified cassette machine, aptly named the E-1, Easy Machine, in

1980, after the network librarians for the blind and physically handicapped had endorsed the idea for such a machine. In response to a request for proposals in 1980, NLS received two design samples. The contractor selected for the job produced fifty-five prototypes that were available for evaluation and testing by June 1982. These prototypes were sent to an independent contractor who conducted an evaluation to determine whether the E-1 was suitable for patrons who either had no previous experience with cassettes or could not operate the standard NLS cassette player. The contractor found the machines to be popular with elderly readers, but also identified a voltage variance problem that caused the microprocessor controlling the automatic side-advance feature to malfunction; the problem was quickly corrected. In the second phase of the evaluation, a steady decrease in machine and operating problems was noted.

The E-1 received little attention from NLS during 1983 and 1984 because of production difficulties that resulted in an inadequate supply of standard cassette machines. Moreover, the newly formed Ad Hoc Audio Equipment Advisory Committee composed of users, librarians, and repair personnel recommended that a more thorough evaluation involving libraries and patrons be conducted before the E-1 went into production. To this end, one thousand E-1s were produced in 1985 for field testing by librarians and talking-book patrons. In addition, the Braille Institute of America began a separate evaluation using two hundred machines.

The evaluation revealed that many regional librarians found the operating instructions for the new cassette players unclear and were confused about the purpose of the E-1. Since the evaluation, the operating instructions have been rewritten, and the E-1 went into production at the end of 1986. Forty thousand of these simplified cassette players

The E-1, designed for easy operation, has many automatic features and few controls.

A side panel can be removed to reveal a manual side-selection switch and outlets for accessories.

were produced initially, to be issued only to selected readers who because of age or disability were unable to operate the standard NLS cassette players or were uncomfortable with the complex operation of the standard machines.

The Easy Machine (E-1) represents a revolutionary departure from previously produced talking-book cassette players. It has only two main controls—a sliding switch and a push button, both located at the front of the machine. Moving the sliding switch to the right starts the tape and selects the volume. Thus, stop, play, and volume are combined in a single control. Depressing the button rewinds the tape. The cassette is ejected by simply sliding open a door and depressing the tape deck; no control switch is required. The tape rewinds automatically when a cassette is inserted into the tape deck, and a beep signals when the tape is ready to play. At the end of each side, the motor reverses, and the track is switched to play in the new direction. Thus, the reader never needs to turn the cassette over. The side-switching-device incorporates a push button that, when pressed, sounds from one to four tones to indicate which side is being played.

Although simple to operate, the E-1 is actually a very complex instrument that uses recently developed technology involving microprocessors to control the various functions. Moreover, to achieve such an easily operated machine, options normally included in a cassette player had to be sacrificed. Thus, the E-1 does not have fast-forward, variable-speed, or tone controls. The automatic side-changing feature can, however, be overridden by a switch on the side of the machine. In the manual side-selection mode, the machine stops at the end of each side of play.

Mock-up of design for combination machine.

The Combination Machine

The suggestion of a budget-conscious Congress that providing a combined record player/tape deck might be less expensive than providing two separate talking-book machines to eligible readers who needed both types of playback capabilities was the impetus for the new combination machine that is in the final stages of development by NLS. NLS began studying the feasibility of producing a machine in which a single set of controls would operate both a record player and a tape deck as early as 1973. It was hoped that such a combination machine would offer the advantages of smaller size, less weight, greater ease of operation, and lower unit cost.

Initial progress was slow, but the push for a combined machine was given renewed impetus by a

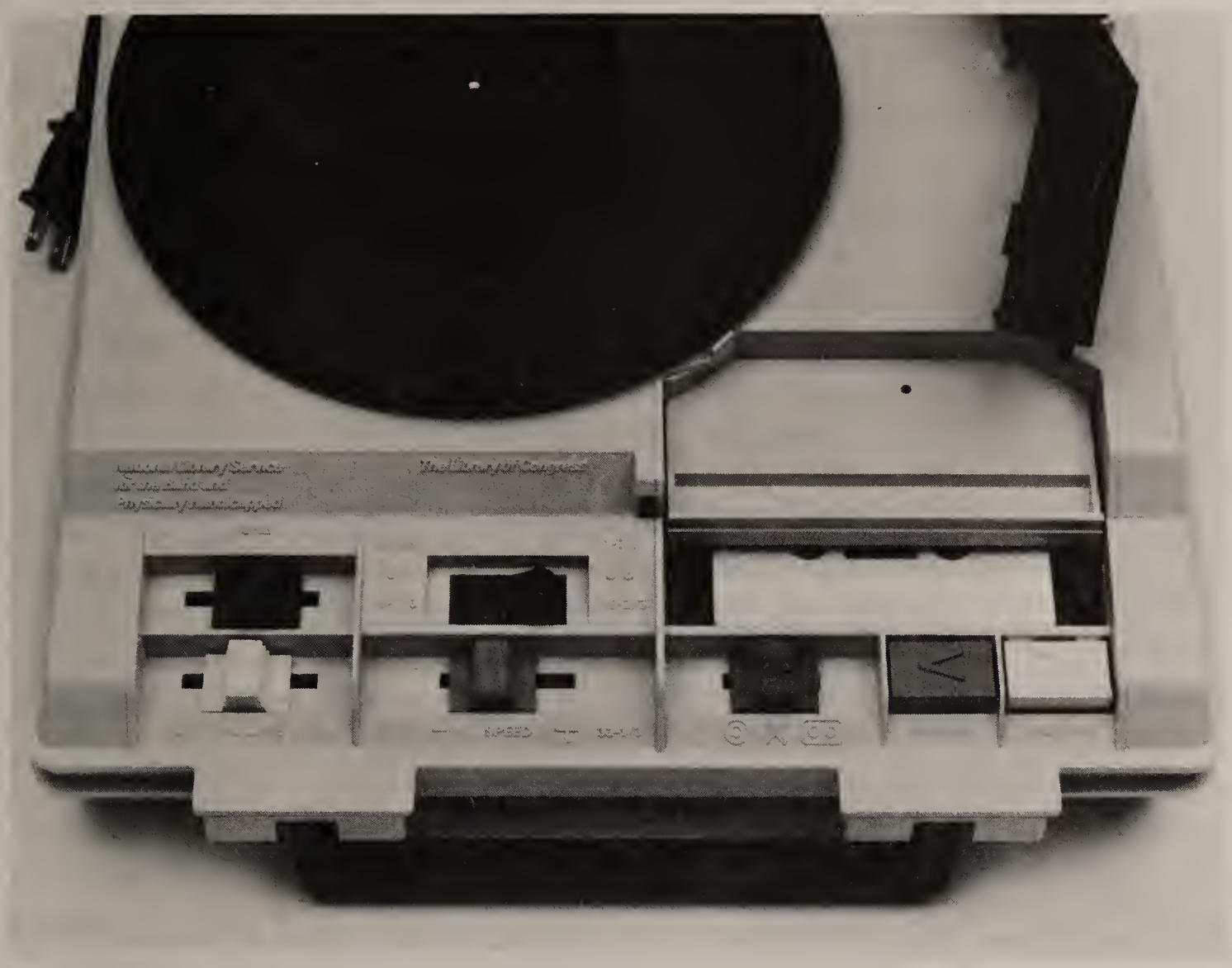
Working model of early combination machine.

1975 study that concluded NLS should pursue developing a combination player that would serve as the basic machine for the talking-book program. Work on the design and engineering of such a machine began in 1977, and a rough prototype was available the following year. However, before going ahead with further work on the combination machine, NLS decided that developing the E-1 should take precedence, partly because the combination machine would use some of the technology being developed for the E-1. For example, the combination machine uses the same deck as the E-1 and has the same automatic side-switching feature.

Both the record player and the tape deck are very different from previously existing talking-book

The combination machine plays both tapes and cassettes and incorporates many of the automatic features of the E-1.

playback machines. A single rewind switch rewinds both tapes and flexible discs (yes, the needle can move backward on the record!). Both the tape deck and the phonograph also have fast-forward and



The combination machine offers automatic features and user-controlled options.

variable-speed capabilities. The tone arm is removed from a disc by pressing down rather than lifting up (an easier motion for many physically handicapped people); the downward pressure automatically retracts the needle, thus preventing damage to the disc. A user can switch off the disc player without removing the needle from the record and even close the cover and move the machine without changing the needle's position on the disc. The tone arm is also equipped with a device for locating the edge of the disc or turntable and the grooves leading to the beginning of the recording. Cassette features include automatic reverse and track-switching, which allow an entire cassette to be played without the user's having to do anything after starting the machine.

Many modifications to the combination machine have been made in response to suggestions from an eight-member consumer advisory panel, as well as in response to improved technology. The consumer panel, for example, recommended using speaker components that would achieve the best sound possible. Other major concerns were the machine's weight and portability (the final product weighs about ten pounds and is twelve inches square and six inches high) and simplified operation of the cassette deck.[7]

After a design model of the combination machine has been approved, it will undergo the same process of evaluation and field testing that was used for the Easy Machine. When it is available, the combination machine will represent a major step forward in the technology of talking-book machines.

Accessories

In addition to including such features as raised markings on the control keys of all its talking-book machines and cassette players, NLS also provides a number of accessories that are useful to visually impaired and physically handicapped users. Some of these devices started out as auxiliary mechanisms, but were later built in as standard features of the machines. For example, a variable-speed device that plugged into the early machines, allowing the user to speed up or slow down the rate at which the tape played, was later incorporated into the cassette player itself.

Other accessories have been designed to enable patrons with specific impairments to operate the machines independently. For example, NLS makes available a tone-arm clip that can be attached to the tone arm of a talking-book phonograph player to help patrons with poor manual dexterity—including many older, arthritic patrons—operate that mechanism more easily. NLS also provides special extension levers for cassette player

control switches in order to provide increased leverage for patrons who have limited use of their hands or fingers.

Remote control devices that turn talking-book and cassette machines on and off are also available for patrons who are unable to handle the on-off switch. A light touch activates the transmitter, which is available in three different frequencies so that units operating in the same range (for example, from adjacent beds in a nursing home) will not interfere with one another. A breath switch that can be plugged into the transmitter is also available for severely disabled patrons.

Earphones with an individual volume control for each ear are provided for private listening and for patrons with some hearing loss. In response to users' complaints about discomfort resulting from wearing the heavy NLS-provided headphones for extended periods, NLS now has available a lightweight headset, an accessory that has proven very popular. Pillowphones designed to go under a patron's pillow for comfortable, yet private, listening are also available. The headphones and pillowphones are commercial equipment modified for monaural listening according to NLS specifications. Auxiliary amplifiers for earphones are also available for patrons with severe hearing loss. Certification of need is required before these amplifiers are issued because their high volume (up to 134 decibels) could damage normal hearing.

The responsiveness of NLS to the needs of individual patrons is exemplified by another accessory, a solar-powered battery-recharging unit, which is now available to patrons living in remote areas and to campers. This device has an interesting history. An American woman living in the jungles of Brazil without access to electricity, with no way to recharge batteries, and with very limited mail service mentioned her interest in the talking-book program in a letter to NLS. Library engineers

tone arm clip

extension levers

remote control, breath switch

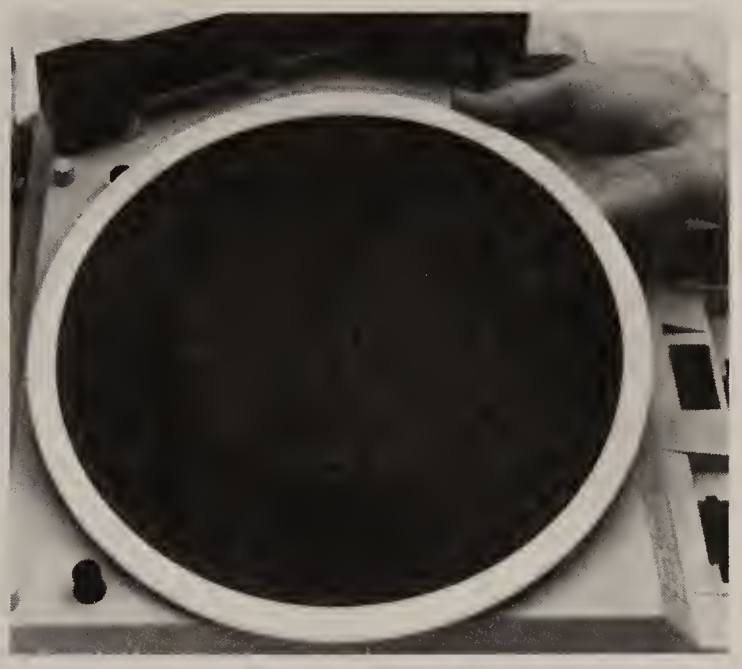
earphones

pillow speaker

WARNING: IMPROPER USE OF THIS DEVICE CAN
RESULT IN SERIOUS OR PERMANENT HEARING
LOSS — FOR MORE DETAILED INFORMATION
REFER TO INSTRUCTION BOOKLET

amplifier

solar battery pack and panel



rigid holder for flexible discs

responded by adapting commercially available components into a lightweight, heavy-duty panel of small silicon solar cells. The panel can operate a cassette machine (modified with a jack to accept the solar-powered source) in direct sunlight or can recharge batteries. Two hundred of these solar panels were produced in 1981 after NLS discovered that many other prospective readers of talking books in remote areas could benefit from this innovative technology.

The 1980s "family" of talking-book machines.

The Future of the Talking-Book Program

Even with the Easy Machine and a combined disc/tape player in the final stages of production, NLS is not satisfied that it has achieved the ultimate talking book machine. Just as microprocessors—which are small and inexpensive, yet able to handle complicated functions—came into use in the new generation of talking-book machines, NLS will continue to look at evolving audio technology to enable the talking-book program to better serve its blind and physically handicapped patrons.

Possibilities that NLS may consider in the future include putting talking books on compact discs, which can store enormous quantities of information. An entire print set of encyclopedias, the *Britannica,* for example, can be stored on a single disc. NLS is also exploring the feasibility of using digital recording capabilities and has contracted with AFB and APH to investigate the effects of digital recording on mastering. Currently, talking-book masters are stored on magnetic tape, which is subject to degrading because of print-through from one side of the tape to another. Storing material on digital masters would eliminate degrading inasmuch as the quality of the master would be limited only by the life of the tape itself. NLS is considering either using the digital process for the initial mastering or transferring the magnetic-tape master to a digital master. The digital process also offers NLS a way to preserve old masters: they can be cleaned by filtering and enhancing and then transferred to digital tape, where they will be safe from degrading. As it has done with technological developments in the past, NLS intends to keep abreast of advances in the digital recording field and to incorporate them into the program if they prove feasible.

What began as the dream of a few pioneers who saw in a new invention the possibility of making information more accessible to blind persons has become a national library of talking books and playback equipment administered by a network of cooperating local, state, and national jurisdictions. AFB and APH, leaders among the pioneers, continue their roles as consultants and producers. Innovations by pioneers in the commercial recording industry are still being incorporated into the talking-book program, even as the needs of handicapped readers continue to challenge available technology.

Appendix

Playback Equipment

Fiscal Year	Model	Machine	Manufacturer
1932-34	Machines were developed and produced by American Foundation for the Blind. Blind persons purchased them. Private groups raised funds to purchase machines for persons unable to do so themselves.		
1935	10,11	disc	American Foundation for the Blind (AFB)
1935-42			WPA project under Library of Congress directed by AFB
1936	20,11	disc	AFB
1937	20,12,11A	disc	AFB
1939	18,19,20	disc	AFB
1940	18	disc	AFB
1941	18	disc	AFB
1942	22	disc	AFB
1943-44	Repairs only		
1945-46	25	disc	AFB
1947	30,000	disc	Sandwick Bowen Corporation
1948	R	disc	U.S. Recording Company
1949	S	disc	U.S. Recording
1950	T	disc	U.S. Recording
1951	A	disc	U.S. Recording
1952	Testing Model A		
1953	Distributing Model A		
1954	B	disc	Pennsylvania Association for the Blind, Inc.
1955	B	disc	Pennsylvania Association

1956	C	disc	Pennsylvania Association DeWald Radio Manufacturing
1957	D	disc	Philadelphia Association for the Blind, Inc. U.S. Recording
1958	D,D1	disc	Philadelphia Association
	D2		Stromberg-Carlson Company
1959	AD-2	disc	Warwick Manufacturing Company
1960	AD-3 BTS	disc	Westinghouse Electric Corporation Fanon Electric Industries
1960-68	Open-reel tapes produced for use with reader-supplied commercial playback equipment.		
1961	AD-4	disc	Westinghouse
1962	AD-5	disc	Warwick
1963	AD-6	disc	Warwick
1964	AD-7	disc	Warwick
1965	AE-1	disc	Westinghouse
1966	AE-2	disc	Warwick Electronics, Inc.
1967	AE-3	disc	Waters Conley Company, Inc.
	AE-4	disc	Warwick Electronics
1968	AE-5 AE-5A	disc	Warwick Electronics
1968	Flexible discs introduced.		
1968	Commercial cassette players purchased for trial use from Philips, Lloyd (Sanyo), Sears Roebuck (Sanyo).		
1969	AE-6	disc	Waters Conley
	M8350	cassette	General Electric Company
1970	A-70	disc	Waters Conley
	M8353 M8352	cassette	General Electric

1971	A-71	disc	Waters Conley
	B-71	disc	Waters Conley
	B-71A	disc (overseas)	Waters Conley
	M8354	cassette	General Electric
1972	A-71	disc	Waters Conley
	A-72	disc	Waters Conley
1973	A-73	disc	Waters Conley
	C-73	cassette	General Electric
1974	A-74	disc	Waters Conley
	C-74	cassette	General Electric
1975	A-75	disc	Interstate Industries, Inc.
	C-75	cassette	Telex Communications, Inc.
1976	A-76	disc	Interstate Industries
	C-76	cassette	Telex
	C-75A	cassette	Telex
1976-77	C-76	cassette	Telex
1977	A-77	disc	Interstate
1977	C-77	cassette	Telex
	C-76	tooling	Telex
	CTBM	combination tooling	Video Research Corporation
1978	A-78	disc	Interstate
	C-78	cassette	Telex
1979	A-79	disc	Interstate
	B-79	disc (overseas)	Interstate
	C-79	cassette	Telex
1980	A-80	disc	Interstate
	C-80	cassette	Interstate
	S-80	"simple" cassette	Video Research Telex (research)
1981	C-1, E-1, CT-1	cassette	Telex (E-1 and CT-1 under development through 1987)
1982	C-1	cassette	Telex
1983	C-1	cassette	Telex
1984	C-1	cassette	Telex

1985	C-1	cassette	Telex
1986	C-1	cassette	Telex
1987	C-1	cassette	Telex
	E-1	"simple" cassette	Telex
	C-2	cassette	LaBarge Electronics (field test)
1988	CT-1	combin-ation	Telex (field test)

Notes

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